The Ecoscan 9(3&4) : 791-794, 2015
AN INTERNATIONAL BIANNUAL JOURNAL OF ENVIRONMENTAL SCIENCES

RELATIVE INTRINSIC TOXICITY OF NOVEL PESTICIDES AGAINST GREENHOUSE WHITEFLY, *TRIALEURODES VAPORARIORUM* (WESTWOOD) AND RED SPIDER MITE, *TETRANYCHUS LUDENI* ZACHER

L. KASHYAP[1]*, ANIL[2] AND D. C. SHARMA[3]
[1]Department of Plant Protection, Lovely Professional University, Jalandhar - 144 410, Punjab, INDIA
[2]Department of Entomology, Bihar Agricultural University, Sabour - 813 210 (Bhagalpur), Bihar, INDIA
[3]Department of Entomology, CSK HPKV, Palampur -176 062 (Kangra), Himachal Pradesh, INDIA
e-mail: lokssi@gmail.com

ABSTRACT

The relative toxicity of novel pesticides possessing insecticidal and/or acaricidal properties was studied against immature and adult stages of greenhouse whitefly and red spider mite under laboratory conditions. Amongst them, azadirachtin was found to be highly toxic against 2[nd] instar nymphal stage of *T. vaporariorum* with lowest median lethal concentration (0.00046%) followed by abamectin (0.00051%), acetamiprid (0.00068%), bifenthrin (0.00112%), spinosad (0.00115%), buprofezin (0.00240%) and mineral oil (0.05632%) whereas in case of adults, abamectin resulted in highest toxicity with lowest median lethal concentration (0.00095%) followed by acetamiprid (0.00108%) azadirachtin (0.00123%), bifenthrin (0.00261%), buprofezin (0.00412%), spinosad (0.00514%) and mineral oil (0.09533%). Abamectin was also found highly toxic against respective protonymphal and adult stages of *T. ludeni* with lowest median lethal concentration (0.00021 and 0.00043%) followed by bifenthrin (0.00043 and 0.00065%), hexythiazox (0.00216 and 0.00450%), azadirachtin (0.00220 and 0.00664%), dicofol (0.00346 and 0.01059%), propargite (0.00484 and 0.01621%) and mineral oil (0.06992 and 0.10183%).

KEY WORDS
Greenhouse whitefly
Red spider mite
Novel pesticides
Relative toxicity

Received : 27.09.2014
Revised : 24.05.2015
Accepted : 27.08.2015

*Corresponding author

INTRODUCTION

Tomato (*Solanum lycopersicum* Linnaeus) is one of the most widely produced and consumed vegetable in the world, both for fresh market and processed food industries. Globally, it is grown over an area of 4.776 million hectares with a total production of 160.850 million tonnes. India stands for second position after China with a total production of 18.653 million tonnes over an acreage of 0.907 million hectares (Anonymous, 2013). Tomato is one of the most remunerative cash crops of mid-hills in Himachal Pradesh with a total production of 0.388 million tonnes (Vanitha *et al.*, 2013) where it is grown under open and protected conditions. In this state, the launching of "*Pandit Deen Dayal Kisan Bagwan Samridhi Yojna (PDDKBSY)*" has resulted tremendous increase in area under protected cultivation and with this increasing acreage under protected cultivation, the availability of quality tomato can be increased manifold during off-season.

Tomato crop is more prone to insect-pests due to their tenderness and softness, and majority of insects and mite pests associated with protected cultivation belonging to the order Homoptera (aphids, whiteflies, mealybugs), Thysanoptera (thrips), Diptera (leafminers) and Acarina (mites) (Papasolomontos, 2004; Perdikis *et al.*, 2008; Mehta *et al.*, 2012). Amongst these, greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) (Hemiptera: Aleyrodidae) and mite, *Tetranychus ludeni* Zacher (Acari, Tetranychidae) are important ones and causing economic damage to tomato crop under protected conditions. For managing these pests, the use of chemical pesticides is one of the quick and effective method of pest management. Thus, the intrinsic toxicity of various conventional insecticides and acaricides have already been studied against different insect and pests of tomato (Chinnabai *et al.*, 2000; Sood *et al.*, 2006; Dimetry *et al.*, 2008; Chueca *et al.*, 2009) but the continuous use of same group of chemicals has resulted in plethora of problems including insecticides resistance and insect resurgence. In order to tackle this situation, the present investigation was devised to study the relative intrinsic toxicity of novel pesticides attributing insecticidal and/or acaricidal properties against nymphal and adult stages of *T. vaporariorum* and *T. ludeni*.

MATERIALS AND METHODS

The experiment was conducted during 2010-11 inside hi-tech insectary maintained at 26±1°C, 60±5% RH and 16:8 photoperiod (Light: Dark), Department of Entomology, Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur (Himachal Pradesh), India. French bean (*Phaseolus* *vulgaris*) (cv. Contender) plants were raised in plastic pots (9.5 x 9.5 cm) for maintaining test insect and mite culture and further evaluation of intrinsic toxicity. The initial culture of *T. vaporariorum* and *T. ludeni* were taken from insectary of the department for mass multiplication. The details of the insecticides and miticides assessed in present study are indicated in Table 1.

The intrinsic toxicity of insecticides against nymphs of greenhouse whitefly was determined using bioassay method described by Cahill *et al.* (1996) wherein second instar nymphs were counted on marked leaves and these leaves were dip treated for 30 seconds with each test concentration. However, leaf disc bioassay method described by Cahill *et al.* (1995) was adopted for assessing toxicity against adults of *T. vaprariorum*. In this method, leaf discs (dia 4.5 cm) were dip treated for 30 seconds in each test concentration, shade dried and placed over the bed of agar gel (1.3%) in glass Petri dishes (dia 5.0 cm) by keeping ventral surface of leaf discs exposed for feeding. Thereafter, counted adult population (2-3 day old) were demobilized by exposing to low temperature in freezer for 2-3 minutes and transferred to each Petri plates which were then covered with close fitted ventilated lids. After the activeness of adults, Petri plates were inverted to normal orientation for facilitating feeding.

Petri dish bioassay method as described by Bowie *et al.* (1988) was adopted for determining the toxicity of miticides against protonymphs and adults of mite. Each test concentration (2ml) was sprayed on leaves with the help of Potter's tower and allowed to dry on filter paper. Thereafter, counted neonate protonumphs and adults were released on treated leaves placed over agar gel (1.3%) in Petri dishes.

Each test concentration was replicated thrice and mortality data were recorded after 48 hours of release. The intrinsic toxicity of insecticides and miticides against *T. vaporariorum* and *T. ludeni* were worked out by evaluating 5-6 working concentrations of each pesticide giving mortality between 10-90 per cent. Further, the corrected per cent mortality was calculated using Abbott's formula (Abbott, 1925) and data were subjected to Probit analysis (Finney, 1971) for evaluation of median lethal concentration and subsequent relative intrinsic toxicity.

RESULTS AND DISCUSSION

Relative intrinsic toxicity of insecticides against different stages of *T. vaporariorum*

Nymphal stage

The perusal of data (Table 2) revealed that azadirachtin showed the lowest median lethal concentration (0.00046%) against second instar nymphal stage of greenhouse whitefly followed by abamectin (0.00051%) and acetamiprid (0.00068%). However, the highest median lethal concentration (0.05632%) was observed for mineral oil followed by buprofezin (0.00240%) and spinosad (0.00115%). The order of relative intrinsic toxicity was observed as 'azadirachtin (122.4) > abamectin (110.4) > acetamiprid (82.8) > bifenthrin (50.2) > spinosad (48.9) > buprofezin (23.4) > mineral oil (1.0)'. The highest bioactivity of azadirachtin against second instar nymphs of *T. vaporaroirum* might be attributed due to its complex chemical configuration and multiple mode of action. These findings are also supported by Mitchell *et al.* (1997) and Kumar and Singh (2014), who have also reported higher efficacy of azadirachtin against nymphs of *T. vaporariorum* and *Bemisia tabaci*, respectively.

Adult stage

It is evident from Table 3 that the highest median lethal concentration (0.09533%) against adults of *T. vaporaroirum* was noticed for mineral oil followed by spinosad (0.00514%) and buprofezin (0.00412%). However, abamectin showed lowest median lethal concentration (0.00095%) followed by acetamiprid (0.00108%) and azadirachtin (0.00123%).

Table 1: Details of the evaluated insecticides and miticides

Common name	Commercial formulation	Manufacturer/Source
Abamectin	Abacin 1.9 EC	Crystal Phosphates Ltd., New Delhi
Acetamiprid	Pride 20 SP	Dow Agro Science India Pvt. Ltd., Mumbai
Azadirachtin	Neemazal-TIS 1 EC	E.I.D. Parry India Ltd., Chennai
Bifenthrin	Talstar 10 EC	FMC India Pvt. Ltd., Bangalore
Buprofezin	Ben 25 EC	Nagarjuna Agrichem Ltd., Hyderabad
Dicofol	Colonal-S 18.5 EC	Indofil Chemical Company, Mumbai
Hexythiazox	Xmite 5.45 EC	Biostadt India Ltd., Mumbai
Mineral oil	Servo Agrospray T	Indian oil corporation, Mumbai
Propargite	Omite 57 EC	Dhanuka Agritech Ltd., Haryana
Spinosad	Success 2.5 SC	Dow Agro Science India Pvt. Ltd., Mumbai

Table 2: Relative intrinsic toxicity of insecticides against nymphal stage of *T. vaporariorum*

Insecticide	d.f	Fiducial limit (%)	Regression equation	LC_{50}(%)	Relative toxicity
Abamectin	5	0.0003-0.0008	Y = 2.231 + 1.620x	0.00051	110.4
Acetamiprid	5	0.0004-0.0009	Y = 2.006 + 1.629x	0.00068	82.8
Azadirachtin	4	0.0003-0.0007	Y = 2.515 + 1.494x	0.00046	122.4
Bifenthrin	4	0.0007-0.0017	Y = 1.158 + 1.586x	0.00112	50.2
Buprofezin	5	0.0016-0.0033	Y = 1.373 + 1.523x	0.00240	23.4
Mineral oil	4	0.0357-0.0769	Y = 0.929 + 1.479x	0.05632	1.0
Spinosad	3	0.0008-0.0015	Y = 1.806 + 1.548x	0.00115	48.9

Table 3: Relative intrinsic toxicity of insecticides against adult stage of *T. vaporariorum*

Insecticide	d.f	Fiducial limit (%)	Regression equation	LC_{50}(%)	Relative toxicity
Abamectin	4	0.0006-0.0014	Y=1.819+1.607x	0.00095	100.3
Acetamiprid	4	0.0007-0.0016	Y=1.820+1.563x	0.00108	88.2
Azadirachtin	5	0.0008-0.0017	Y=2.148+1.362x	0.00123	77.5
Bifenthrin	3	0.0017-0.0037	Y=1.158+1.588x	0.00261	36.5
Buprofezin	3	0.0023-0.0061	Y=2.072+1.311x	0.00412	28.8
Mineral oil	5	0.0636-0.1429	Y=0.257+1.591x	0.09533	1.0
Spinosad	4	0.0034-0.0078	Y=0.642+1.607x	0.00514	20.6

Table 4: Relative intrinsic toxicity of acaricides against protonymphal stage of *T. ludeni*

Acaricide	d.f	Fiducial limit (%)	Regression equation	LC_{50}(%)	Relative toxicity
Abamectin	4	0.0001-0.0003	Y=1.616+1.474x	0.00021	332.9
Azadirachtin	5	0.0013-0.0034	Y=1.736 +1.392x	0.00220	31.7
Bifenthrin	4	0.0003-0.0006	Y=2.720+1.391x	0.00043	162.6
Dicofol	3	0.0020-0.0059	Y=2.775+1.445x	0.00346	20.2
Hexythiazox	5	0.0013-0.0030	Y=2.089+1.605x	0.00216	32.7
Mineral oil	4	0.0436-0.1121	Y=0.141+1.708x	0.06992	1.0
Propargite	3	0.0027-0.0086	Y=1.029+1.478x	0.00484	14.4

Table 5: Relative intrinsic toxicity of acaricides against adult stage of *T. ludeni*

Acaricide	d.f	Fiducial limit (%)	Regression equation	LC_{50}(%)	Relative toxicity
Abamectin	4	0.0002-0.0007	Y=2.402+1.587x	0.00043	236.8
Azadirachtin	5	0.0040-0.0109	Y=2.011+1.639x	0.00664	13.7
Bifenthrin	4	0.0003-0.0010	Y=2.197+1.541x	0.00065	156.6
Dicofol	3	0.0065-0.0173	Y=1.621+1.668x	0.01059	9.6
Hexythiazox	5	0.0027-0.0076	Y=2.264 +1.654x	0.00450	22.6
Mineral oil	4	0.0634-0.1635	Y=1.536+1.425x	0.10183	1.0
Propargite	3	0.0085-0.0312	Y=2.179+1.277x	0.01621	6.2

Abamectin, acetamiprid, azadirachtin, bifenthrin, buprofezin and spinosad were 100.3, 88.2, 77.5, 36.5, 28.8, 23.1 and 20.6 times more toxic than mineral oil, respectively. Several workers have also reported that acetamiprid was very effective for the control of *T. vaporariorum* (Chinnabai *et al.*, 2000; Sood *et al.*, 2006) which corroborate the present findings. The intrinsic toxicity of buprofezin are in close conformity with those observed by Sood and Sharma (2010) against adults of *T. vaporariorum*.

Relative intrinsic toxicity of acaricides against different stages of *T. ludeni*

Protonymphal stage

The data on relative intrinsic toxicity of acaricides against protonymph of *T. ludeni* (Table 4) revealed that abamectin was found to be the most toxic with lowest median lethal concentration (0.00021%) followed by bifenthrin (0.00043%) and hexythiazox (0.00216%). However, the highest median lethal concentration (0.06992%) was noticed for mineral oil showing less toxicity followed by propargite (0.00484%) and dicofol (0.00346%). The order of relative toxicity was observed as 'abamectin (332.9) > bifenthrin ((162.6) > Hexythiazox (32.7) > azadirachtin (31.7) > dicofol (20.2) > propargite (14.4) > mineral oil (1.0)'. The present finding on abamectin are in conformity with the observation of Baranowski (1991). Alzoubi and Cobanglou (2007) have also reported the higher nymphicidal activity of bifenthrin which affirms the present observation. The toxicity of neem against immature stages of *T. urticae* was studied by Dimetry *et al.* (2008) which substantiates the present findings on azadirachtin. Mineral oil showed lowest toxicity against protonymphs which is in conformity with the finding of Chueca *et al.* (2009), who have also observed the toxicity of mineral oil against red spider mite at higher doses.

Adult stage

The highest median lethal concentration (0.10183%) was noticed for mineral oil showing lowest toxicity against adults of *T. ludeni* (Table 5) followed by propargite (0.01621%) and dicofol (0.01059%). However, abamectin exhibited highest toxicity with lowest median lethal concentration (0.00043%) followed by bifenthrin (0.00065%) and hexythiazox (0.00450%). Considering mineral oil toxicity as unity, the corresponding relative toxicity values were found to be 236.8, 156.6, 22.6, 13.7, 9.6 and 6.2 for abamectin, bifenthrin, hexythiazox, azadirachtin, dicofol and propargite, respectively. Akashe (2004) also observed median lethal concentration for abamectin as 0.0004 per cent against adults of *T. urticae* which is in close conformity with the present findings. These present observations are in agreement with those observed by Sahu *et al.* (2008) who determined median lethal concentration of some acaricides against tea spider mite wherein slight variation might be due to the differences in the developmental period of these mite species. Furthermore, Reddy *et al.* (2014) tested five commercially available acaricides against two spotted spider mite, *T. urticae* under laboratory and greenhouse conditions and found abamectin as superior over others.

It can be inferred from present investigation that abamectin, acetamiprid, azadirachtin and bifenthrin showed higher relative intrinsic toxicity against greenhouse whitefly, whereas abamectin, bifenthrin, hexythiazox and azadirachtin resulted in higher relative intrinsic toxicity against red spider mite. Since these pesticides are belonging to different groups and hence can be successively exploited for managing these pests under protected conditions.

REFERENCES

Abbott, W. S. 1925. A method for computing the effectiveness of an insecticide. *J. Econ. Entomol.* **18:** 265-267.

Akashe, V. B. 2004. Toxicity of some newer miticides against *Tetranychus urticae* Koch on roses irrespective of resistance development. *J. Maha. Agril. Univ.* **29:** 94-95.

Alzoubi, S. and Cobanglou, S. 2007. Effects of sublethal dose of different pesticide on the two-spotted spider mite "*Tetranuchus urticae*" and its predatory mites under greenhouse conditions. *World J. Agril. Sci.* **3:** 764-770.

Anonymous 2013. *Agricultural Research Data Book 2013.* IASRI, New Delhi.

Baranowski, T. 1991. Avermectins new group of pesticides for plant protection. In: *Materials of the 31st Research Session of Institute for Plant. Panstwowe Wydawnictwo Rolnicze I Lense*, pp. 214-220.

Bowie, M. H., Chapman, R. B. and Walker, J. T. S. 1988. Monitoring azocyclotin and propargite resistance in European red mite. In: *Proc. Forty One New Zealand Plant Protection Society*. pp.189-192.

Cahill, M., Byrne, F. J., Gorman K., Denholm, I. and Devonshire, A. L. 1995. Pyrethroids and organophosphate resistance in the tobacco whitefly *Bemisia tabaci* (Homoptera: Aleyrodidae). *Bull. Entomol. Res.* **85:** 181-187.

Cahill, M., Gorman, K., Day, S., Denholm, I., Elbert, A. and Nauen, R. 1996. Baseline determination and detection of resistance to imidacloprid in *Bemisia tabaci* (Homoptera: Aleyrodidae). *Bull. Entomol. Res.* **86:** 343-349.

Chinnabai, C. H., Subaratnam, G. V. and Madhumathi, T. 2000. Relative toxicity of some new insecticides to resistant population of *Bemisia tabaci* (Gennadius) infesting cotton in Andhra Pradesh. *Pest Manag. Econ. Zool.* **8:** 1-4.

Chueca, P., Garcera, C., Molto, C., Jacas, E., Urbaneja, J. A. and Pina, T. 2009. Mineral oils can be an alternative to the use of acaricides for the control of red spider mite. *Levante Agricola*. **48:** 121-129.

Dimetry, M. Z., Amer, S. A. A. and Saber, S. A. 2008. Laboratory evaluation of neem formulations with and without additive against the two spotted spider mite, *Tetranychus urticae* Koch. *Acarologia*. **48:** 171-176.

Finney, D. J. 1971. *Probit analysis*. Cambridge University Press. 3rd edition. p. 333.

Kumar, A. and Singh, R. 2014. Bioefficacy of some insecticides against the greenhouse whitefly, *Trialeurodes vaporariorum,* Westwood (Homoptera: Aleyrodidae) on tomoto. *The Bioscan.* **9(3):** 1073-1076.

Mehta, P. K., Sood, A. K., Sharma, P. C. and Banyal, D. K. 2012. *ICAR short course training on pest management in high-value crops under protected environment*. Department of Entomology CSK Himachal Pradesh Krishi Vishvavidyalya Palampur, India. p. 181.

Mitchell, M. J., Smith, S. L., Johnson, S. and Morgan, E. D. 1997. Effects of neem tree compounds azadirachtin, salannin, nimbin and 6-desacetylnimbin on ecdysone 20-monooxygenase activity. *Arch. Insect Biochem. Physiol.* **35:** 199-209.

Papasolomontos, A. 2004. Integrated production and protection in the Mediterranean region under protected cultivation. *Cahiers Options Méditerranéennes.* **31:** 413-424.

Perdikis, D., Kapaxidi, E. and Papadoulis, G. 2008. Biological control of insect and mite pests in greenhouse solanaceous crops. *Eur. J. Plant Sci. Biotech.* **2:** 125-144.

Reddy, D. S., Nagaraj, R., Latha, M. P. and Chowdary, R. 2014. Comparative evaluation of novel acaricides against two spotted spider mite, *Tetranychus urticae* Koch. infesting cucumber (*Cucumis sativus*) under laboratory and green house conditions. *The Bioscan.* **9(3):** 1001-1005.

Sahu, B., Nair, N., Dhar, P. P., Sekh, K. and Somchoudhury, A. K. 2008. Relative toxicity of some acaricides to tea red spider mite, *Oligonychus coffeae* (Nietner) and its predator *Amblyseius longispinosus* Evans. *J. Entomol. Res.* **32:** 53-56.

Sood, A. K. and Sharma, G. 2010. Spatial distribution and management of greenhouse whitefly in Himachal Pradesh. In: *National symposium on perspectives and challenges of integrated pest management for sustainable agriculture*, University Nauni, Solan, Himachal Pradesh. p. 55.

Sood, S., Sood, A. K. and Verma, K. S. 2006. Determination of baseline toxicity of some insecticides to greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) population from North-Western Indian Himalayas. *Pest Manag. Hort. Eco.* **12:** 67-70.

Vanitha, S. M., Chaurasi S. N. S., Singh P. M. and Naik P. S. 2013. *Vegetable Statistics*, Technical Bulletin No. **51**. IIVR, Varanasi, India. p. 250.