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BIOEFFICACY OF SOME INSECTICIDES AGAINST THE GREENHOUSE WHITEFLY *TRIALEURODES VAPORARIORUM*, WESTWOOD (HOMOPTERA: ALEYRODIDAE) ON TOMOTO

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ABSTRACT
Laboratory bioassay of six insecticides namely, spiromesifen, cyantraniliprole, diafenthiuron, chlorfenapyr, buprofezin and oxy-demeton methyl and two botanicals azadirachtin (Neem Baan 1500 ppm) and aqeous dharek drupe extract against first instar nymphs of the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) infesting tomato. These insecticides gave Respective nymphal mortality of these insecticides ranged from 30 to 96, 28 to 92, 22 to 92, 32 to 88, 26 to 86 and 28 to 88 per cent respectively. The range for azadirachtin and dharek drupe extract varied from 28 to 90 and 28 and 88 per cent. Their respective LC_{50} and LC_{90} values of the insecticides obtained were 9.80 and 13.48, 10.38 and 47.79, 18.91 and 85.60, 22.63 and 68.41, 31.45 and 168.65, 206.99 and 1148.15 ppm. Bio-pesticidal formulation, azadirachtin (Neem Baan) and dharek extract resulted in dosage-dependent mortality with LC_{50} and LC_{90} values of 4.45 and 27.58 ppm and 2.84 and 8.60 per cent respectively. On the basis of LC_{50} and LC_{90} values, spiromesifen was found to be most effective followed by cyantrabniliprole. Neem formulation was found more toxic as compared to dharek drupe extract against this pest.

INTRODUCTION

The greenhouse whitefly *Trialeurodes vaporariorum* Westwood (Homoptera: Aleyrodidae) is a pest of polyphagous nature and a serious menace in crops grown under polyhouse conditions especially tomato, capsicum, cucumber and pea. Most of the farmers of the state are dependent on their livelihood on the production of these crops. Both nymphs and adults drain cell sap from the foliage due to which yellowing, fading and drying of leaves take place. The insect also excrete honey dew on which sooty moulds develops (Yamada *et al.*, 1979). In addition to damage caused by direct feeding pressure, whiteflies transmit plant viruses also (Gerling, 1990). The pest has a wide host specificity, fast multiplicity, specific biology, ability to quickly acquire insecticidal resistance; all these factors pose serious problems in its management. Besides above, a wide array of insecticides used for its control, often leave heavy pesticide residue on the crop. All the above characteristics/measures help the pest to quickly acquire resistance to insecticides. Besides above congenial environment of polyhouse also favours rapid breeding of the pest. Indiscriminate and injudicious use of pesticides has posed a major problem of developing insecticidal resistance. In the past, the pest has already been reported to have developed resistance to pyrethroids carbamates and organophosphate including dimethoate (Zheng and Gao, 1995; Rufinger *et al.*, 1999; Sood *et al.*, 2003). Sood *et al.* (2006) reported that the insect is also fastly acuiring resistance even to neonicotinoid insecticide imidacloprid and suggested its restricted use. As the pest acquires resistance to insecticides rapidly, evaluations of new insecticides are needed in order to avoid continuous influence of conventional insecticides. Further botanicals are safer to the environment and can be effective in management of this pest is needed to be studied. Evaluation of toxicity of some novel insecticides against sucking pests has been done and proved effective against the sucking pests (Gavkare *et al.*, 2013). The present study was therefore, undertaken to evaluate new insecticides and botanicals for effective management of the pest and the study will help in finding the most important insecticide/ biopesticide for effective management of the pest and will avoid the problem of insecticidal resistance.

MATERIALS AND METHODS

Six insecticides *viz.*, spiromesifen, cyantraniliprole, diafenthiuron, chlorfenapyr, buprofezin, oxy-demeton methyl and two botanicals viz., neem based insecticide (Neem Baan) and dharek drupe extract were evaluated for their toxicity against first instar nymphs of greenhouse whitefly *Trialeurodes vaporariorum*. The present study was carried out in vegetable laboratory of Department of Entomology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP). A stock culture of greenhouse whiteflies was raised under laboratory conditions on tomato plants, which were planted in earthen pots (25 X 20cm) and plastic cups (7 X 7.5cm). For each insecticide stock solution of 1000 ppm (table 1) were prepared. Desired concentrations of the test insecticides were prepared from the stock solutions.

Azadirachtin

A stock solution of 30 ppm (a.i. bases) was prepared by dissolving 2 mL of Neem Baan (1500 ppm) in distilled water to get final volume of 100 mL.

Dharek drupe extract

The aqueous extract of dharek drupe was prepared under laboratory conditions as per the method adopted by (Sharma and Gupta, 2009).

Intrinsic toxicity

For determining intrinsic toxicity of insecticides, the bioassay method as described by Cahill *et al*. (1996) was followed. Tomato plants maintained in screened cages were exposed regularly to high adult population of *T. vaporariorum* for 24 hour. For obtaining the aggregated population on leaves, all the leaves except the terminal ones were covered with paper bags using clips. This resulted in a cohort of eggs on terminal leaves. Each plant was kept in the laboratory at room temperature and was used after egg hatching. For counting the first instar nymphs, leaf area was marked and the number counted. The plants bearing such leaves were sprayed at run-off using hand atomizer (Tong and Philip, 1995). The nymph mortality was recorded mortality 48 hrs after pesticidal treatment. However, for buprofezin and diafenthiuron, observations on mortality were made 96 hrs after treatment for obtaining desired mortality. For azadirachtin and dharek drupe extract, the mortality was recorded daily till maximum mortality was achieved after treatment. Nymphs which turned light brown and got shriveled after the treatment was considered as dead. Each concentration of the test insecticide including control (emulsified water 0.05%) was replicated five times. Five concentrations of each insecticide which resulted mortality of the nymph in range of 20 to 80 per cent or close to this range were selected for calculation of LC_{50} and LC_{90} values. The mortality due to each insecticide was corrected using Abbott's correction (Abbott, 1925). Corrected mortality data were then subjected to probit analysis (Finney, 1971) to calculate LC_{50} and LC_{90} values.

$$\text{Corrected \% mortality in treatment} = \frac{\text{\% mortality in treatment - \% mortality in control}}{\text{100-\% mortality in control}} \times 100$$

RESULTS AND DISCUSSION

Studies conducted on the intrinsic toxicity of new molecules of the insecticides against first instar nymphs of greenhouse whitefly revealed that all the insecticides evaluated against the pest were toxic. Spiromesifen found to be most toxic whereas conventionally used oxy-demeton methyl was least toxic to the nymphs. The other insecticides viz., cyantraniliprole, diafenthiuron, buprofezin and chlofenapyr were intermediate in toxicity. Spiromesifen gave dosage dependent mortality of the nymphs with LC_{50} and LC_{90} values of 2.72 and 13.48 ppm. The nymph mortality in case of oxy-demeton methyl ranged from 28 and 88 per cent when applied from concentration varying from 62.5 to 1000 ppm. The LC_{50} and LC_{90} values of this insecticide were 145.83 and 699.35ppm. The present finding are in line with the results of Prabhaker *et al*. (2008) who reported LC_{50} value of 0.21-6.08 ug/mL against *Bemesia tabaci* by foliar application. Similarly, Kontsedalov *et al*. (2009) reported LC_{50} values of 0.5 mg/L and 2.6 mg/L against first instar nymphs and eggs of cotton whitefly respectively. Mann *et al*. (2012) also reported LC_{50} vales of 0.46 to 2.08 mg/L against second instar nymphs of *B. tabaci* biotype B. The above studies indicate that this insecticide is very toxic to nymphs of cotton whitefly confirms our results where we have found this insecticide most toxic to the nymphs of another

Table 1: Preparation of stock solutions of chemical insecticides

Sr. No.	Insecticide	Formulation	Quantity of formulation	Final volume (mL)
1.	Oxy-demeton methyl	Metasystox 25 EC	2.0 mL	500
2.	Buprofezin	Applaud 25 EC	2.0 mL	500
3.	Cyantraniliprole	HGW 10 OD	5 mL	500
4.	Diafenthiuron	Pegasus 50 WP	1 g	500
5.	Spiromesifen	Oberon 240 SC	2.1 mL	500
6.	Chlorfenapyr	Intrepid 10 SC	5 mL	500

Tabel 2: Relative toxicity of insecticides against first instar nymphs of *T. vaporariorum* on the basis of LC_{50} and LC_{90} values

Insecticide	LC_{50} (ppm)	LC_{90} (ppm)	Regression equation(Y =)	Relative toxicityof LC_{50}	Relative toxicityof LC_{90}
Spiromesifen	2.72(1.92 and 3.86)	13.48(8.49 and 21.37)	3.15+1.86X	76.09	85.17
Cyantraniliprole	9.80(7.08 and 13.48)	47.79(32.39 and 70.47)	4.19+1.84X	21.12	24.18
Diafenthiuron	18.91(13.49 and 26.30)	85.60(52.48 and 138.03)	2.50+1.95X	10.94	16.78
Chlorfenapyr	22.63(17.91 and 28.60)	68.41(46.56 and 100.53)	1.38+2.66X	9.14	13.41
Buprofezin	31.45(22.38 and 43.65)	168.65(81.28 and 346.73)	2.38+1.75X	6.58	6.81
Oxy-demeton methyl	206.99(141.25 and 295.12)	1148.15(677.08 and 1995.26)	1.60 +1.70X	1	1
Biopesticides					
Azadirachtin(Neem Baan 1500 ppm)	4.45(3.04 and 6.52)	27.58(15.33 and 49.72)	3.95 +1.61X	-	-
DharekExtract	2.84(2.30 and 3.52)	8.60(5.33 and 14.20)	1.11 +2.67 X	-	-

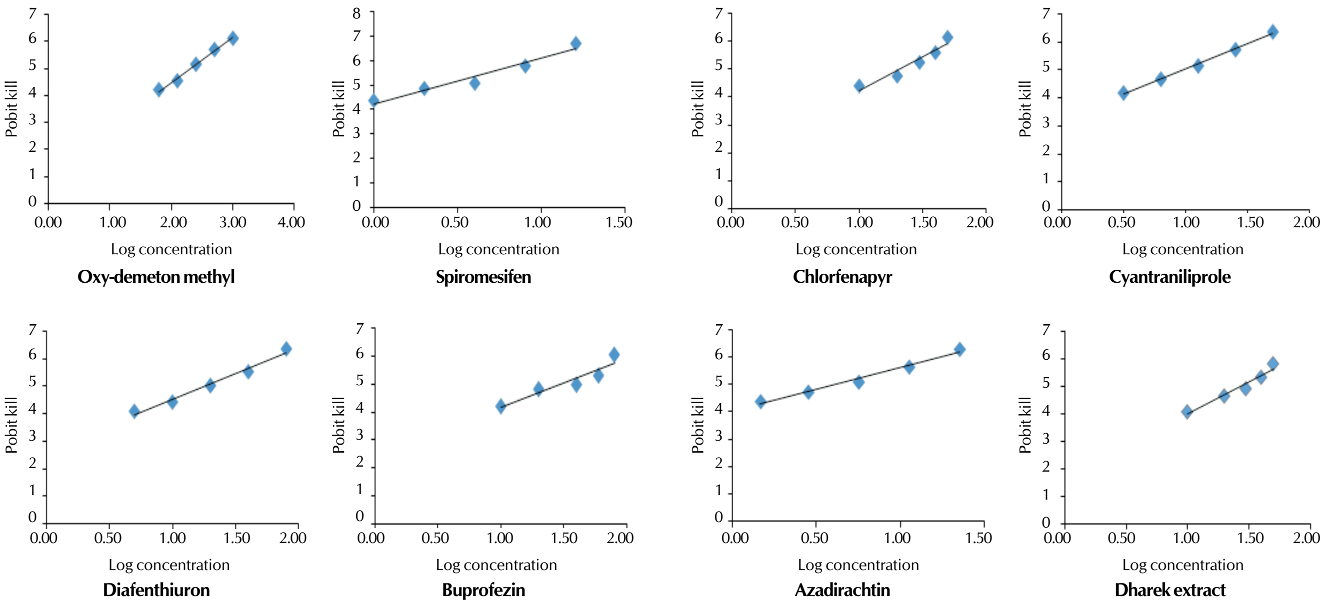

Figure 1: The log (concentration) - probit mortality regression lines for different insecticides and botanical to nymphs of *T. vaporariorum*

related species of whitefly *T. vaporariorum*. Some variation exhibited in the toxicity may be due to the two different white-fly species used in these studies. Similarly, lowest toxicity of oxy-demeton methyl showed that the pest may increase toler-ance to this insecticide with time. Bhasker (2003) reported LC_{50} and LC_{90} values of 145.83 and 699.55 ppm against first instar nymphs. His finding is in close proximity to our result where we have also found this insecticide least toxic having higher LC_{50} and LC_{90} values. Kalyan *et al.* (2012) also reported dimethoate as least effective insecticide against cotton white-fly *B. tabaci* also give support to the present finding where we have also found this demeton methyl is least toxic to the nymph of the sister whitefly *T. vaporariorum*. Various workers (Zheng and Gao, 1995, Rufinger *et al.*, 1999, Sood *et al.*, 2003) also reported that this whitefly has developed resistance to orga-nophosphate, synthetic pyrithroid and carbamates. Results of above workers also confirm our finding of least toxicity of oxydemeton methyl to this insect. As far as the order of toxic-ity was concerned, taking methyl oxy-demeton as base (1.0) on the basis of LC_{50} value, spiromesifen 76.09 times most toxic followed by cyantriniliprole (21.12), diafenthiuron (10.94), chlorfenapyr (9.14) and buprofezin (6.58). On the basis of $LC_{90,}$ toxicity trend was as that obtained in LC_{50} values. Cyantriniliprole was the second most toxic insecticide against nymphs of *T. vaporariorum*. This is a new insecticide tested and LC_{50} and LC_{90} values obtained were also quite low 9.50 and 47.79 ppm as compared to other insecticides which were almost twice or more less toxic. The lower LC_{50} and LC_{90} val-ues of (cyantriniliprole) also indicated that this insecticide was quite toxic to this pest. Azadirachtin resulted LC_{50} value of 4.45 ppm and LC_{90} of 27.58 ppm was found effective than dharek drupe extract where LC_{50} value of 2.84 per cent and LC_{90} of 8.60 per cent were obtained. Sood and Sharma (2010) obtained LC_{50} of 0.0012 per cent of azadirachtin against the second instar nymphs of greenhouse whitefly, *T. vaporariorum* which was slightly in the present study. Our results nearly agree with the findings of Rawat *et al.* (2011) who reported LC_{50} and LC_{90} value of azadirachtin against *M. persicae* as 4.59 ppm and 23.44 ppm, respectively.

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