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Relative toxicity of selected insecticides against adult whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae) transmitting Mesta yellow vein mosaic virus

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Abstract
Whitefly (*Bemisia tabaci*) is an important pest of more than 600 host plant species and vector of various plant *begomovirus*. Bioassay of five insecticides namely, imidacloprid 200 SL (Confidor), flonicamid 50 WG, (Ulala), spiromesifen 240 SC, (Oberon) diafenthiouron 500 SC (Pegasus) and dimetheoate 30 EC (Tafgor) were tested against adult whitefly of kenaf crop. These insecticides gave adult whitefly mortality in ranged of 30 to 88, 22 to 60, 25 to 65, 28 to 75 and 20 to 50 per cent respectively under controlled laboratory conditions after 24 hours treatments. Among the insecticides studied, imidacloprid was found most toxic (LC_{50}-6.6 ppm) to adult whiteflies followed by diafenthiouron (LC_{50}-22.59 ppm). Similarly, the insecticides flonicamid (LC_{50}-24.85 ppm) and spiromesifen (LC_{50}- 28.37 ppm) possess toxic against whitefly but dimetheoate (LC_{50}-7100 ppm) was found least toxic. On the basis of LC_{50} values, imidacloprid was found most toxic to adult whiteflies followed by diafenthiouron and emerged as best insecticides for managing the whiteflies.

Keywords: *Bemisia tabaci*, *H. cannabinus*, insecticides and management

1. Introduction

Bemisia tabaci (Gennadius), is a pest of more than 600 host plant species including fibre crops, ornamentals plants, vegetables, many species of weeds and spices [24, 17, 19, 14, 16, 29, 18, 28]. Whitefly is a highly adaptive insect which feeds on different species of plants [11, 19] and continuously to be identified on new host species [25]. Whitefly is a vector of more than 100 plant viruses [14]. New biotype of different viruses' exhibit differences in virus transmission, endosymbionts, development rate, transmission efficiency and physiological host damage. Populations of whiteflies induce high losses and occur worldwide in the fibre crops. Direct feeding causes damage and physiological disorders in host plant. Secretion of honey dew and contamination with fungus causes loss in plants after virus transmitted by whiteflies [10]. The polyphagous feeding habit of whiteflies increases the probability to acquire and transfer plant viruses from weeds and other host species. Most of the farmers of the state rely on kenaf crop for their livelihood but due to wide host range, specific biology, high rate of multiplicity and quickly acquires resistance pose problems in its management. Due to strong sucking cell sap habits of both adult female, male whitefly and their nymphs, the entire plant leaves become yellowing and drying.

Mesta yellow vein mosaic virus (MeYVMV) transmitted by whiteflies in a persistent manner have monopartite genome belongs to genus *begomovirus*, infecting the kenaf in different parts of India and caused severe economic losses [6, 20]. Due to continuously increased population of infected whiteflies on kenaf plant, this virus reduced fibre and seed yield by 18 to 24% respectively [21]. Considering the importance of kenaf crop and heavy loss caused by this pest, a number of insecticides have been recommended for its effective control. But indiscriminate and injudicious use of insecticides leads to phytotoxicity and pesticides residues on the kenaf crop. Besides, such overdose of pesticides also have been create major problem in insecticidal resistance. Rufinger *et al.* and Sood *et al.* [22, 26] also reported that this pest have been developed resistance to pyrethroids carbamates, organophosphate and dimethoate insecticides. Similarly, Sood *et al.* [27] suggested restricted use of neonicotinoid insecticide against this insect due to fastly acquiring resistance. Due to rapid acquiring resistance of whitefly against conventional insecticides, there is urgent need to identify an effective newer, safer insecticide for management of whiteflies in kenaf crop. Evaluation of toxicity of some novel insecticides against sucking pests had been done and proved effective against the sucking pests [9, 23]. Considering the above facts, the present investigation was undertaken to evaluate the efficacy of new insecticides against whitefly under laboratory conditions at different time interval to know how many days after treatment of insecticides would give 100 per cent mortality.

2. Materials and Methods

2.1 Source of whitefly: Whitefly culture was collected from kenaf growing research farm field of ICAR-Central Research Institute for Jute and Allied Fibers and rearing in the glass house on kenaf plants under control conditions. Each pot contained kenaf plants were covered with small plastic cylindrical cage (7.5 x 2.5 cm). After establishment of whitefly culture, all pots were shifted in whitefly rearing house at the temperature of 30 °C with an 18: 6 hours (L: D) photoperiod and 60-70% relative humidity (RH). The adult whiteflies resting over infested leaves were blown off and sufficient number of nymphs along with lid for emergence of uniform aged adults' whitefly.

2.2 Test insecticides: Five test insecticides *i.e.* imidacloprid 200 SL (Confidor), Bayer crop science India limited, Mumbai; flonicamid 50 WG, (Ulala), United Phosphorus (UPL) India, spiromesifen 240 SC, (Oberon) Bayer crop science India limited, Mumbai; diafenthiouron 500 SC (Pegasus) Syngenta India limited, Mumbai; dimetheoate 30 EC (Tafgor), Rallis India limited were used against whitefly during experiments.

2.3 Laboratory bioassay procedure: Bioassay was conducted for estimating the median lethal concentration (LC_{50}) of novel insecticides possessing diversified modes of action, and also for assessing the relative toxicity of conventional insecticide dimetheoate used for the management of whiteflies infesting kenaf. Bioassays were conducted using the protocol of IRAC Method No. 8. Kenaf plants (*Hibiscus cannabinus*, JBM 81) were maintained in pots for experiments that cover with plastic cylindrical cage under controlled glass house conditions. In each pot two plants of kenaf were grown and eight plants each were maintained to carry out the each experiment. When plants were thirty days old and get sufficient numbers of leaves were shifted in the laboratory and top leaves of kenaf plants sprayed with the selected insecticides at recommended dose. Treated kenaf plants immediately covered with plastic cylindrical cage and left for 30 minutes. The newly emerged 30 adult whiteflies in a batch were collected with the help of aspirator in vials and immediately released on treated leaves of kenaf plants that already maintained in a cage. The replication of each insecticides including control was replicated five times. The treated leaves of kenaf plants and whiteflies were used for a single time in each treatment. The observation on adult mortality was recorded at an interval of 24 hours in all the treatments. Six concentrations of each insecticide which resulted mortality of the adult were selected for calculation of LC_{50} value. The mortality due to each insecticide was corrected using Abbott's correction [1]. Corrected mortality datas were then subjected to probit analysis [8] to calculate LC_{50} value.

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

3. Results and Discussion

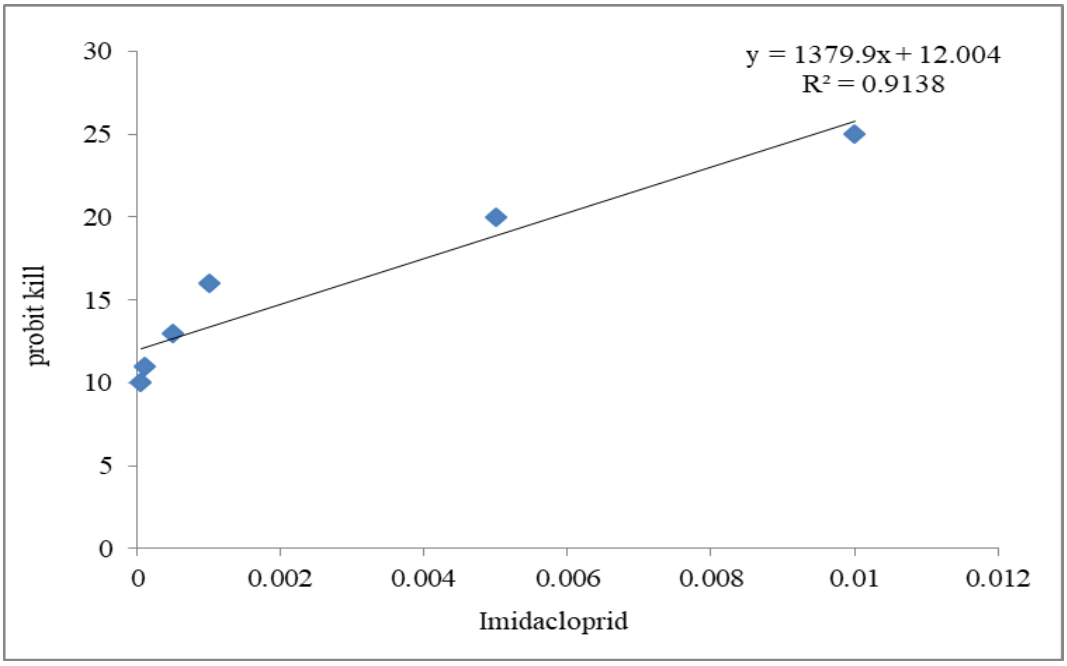
Present investigation conducted on toxicity of new insecticides molecules against adult whitefly of kenaf crop revealed that all the insecticides tested against the whitefly were found toxic at 24 hours. Among the insecticides studied, imidacloprid was found most toxic (LC_{50}-6.6 ppm) to adult whiteflies followed by diafenthiouron (LC_{50}-22.59 ppm) at 24 hours treatment. Similarly, the insecticides flonicamid (LC_{50}-24.85 ppm) and spiromesifen (LC_{50}- 28.37 ppm) possessing toxic against whitefly but dimetheoate (LC_{50}-7100 ppm) was found least toxic. The results revealed that, range of lowest to upper fiducial limit against adult whitefly recorded with imidacloprid was (1.96 to 46.94) followed by diafenthiouron (7.63 to 581.19) insecticide as compared to dimetheoate (2033 to 9870) insecticide. The range of lowest to upper fiducial limit of flonicamid (9.07 to 356.67) and spiromesifen (9.43 to 839.73) was found at par to each other (Table-1 and Figure-1). Relative toxicity of insecticides was estimated by using the median lethal concentrations of individual insecticide. A result revealed that all the insecticides tested, imidacloprid was showed 1075.71-folds more toxic followed by diafenthiouron (314.29- folds) against adult whitefly. Similarly, flonicamid (285.71- folds) and spiromesifen (250.26- folds) insecticide also found more toxic as compared to dimetheoate (1) (Table-1 and Figure-1). Bhaskar [3] reported the least LC_{50} value of insecticide 145.83 ppm against whitefly which finding is in close proximity to our result where we have also found that, insecticide have least toxic having higher LC_{50} value. Kalyan *et al*. [15] also observed that dimethoate found least effective insecticide against cotton whitefly that results also corroborated to our present finding where we have also found this dimethoate is least toxic to the adult whitefly. Devi *et al*. [7] reported that, LC_{50} values calculated for imidacloprid, acetamiprid, thiamethoxam, diflubenzuron, ESSO and SERVO were 0.016, 0.019, 0.041, 0.067, 0.28 and 0.35 per cent, respectively. On the basis of these studies, imidacloprid was found to be the most toxic insecticide against whitefly followed by acetamiprid, thiamethoxam and diflubenzuron that is also agreement to our investigation. The toxic effect of these insecticides revealed a variable response against whitefly which may be exist due to variability in neonicotinoids characteristics that influencing the water solubility in plant tissues especially against those insects having piercing and sucking mouth parts such as whitefly[5]. Sachin and Suchithra [23] reported that imidachloprid, thiamethoxam and cyantraniliprole were found highly toxic to adult whitefly and recorded 100 per cent mortality after four days treatment. In our study we found that, diafenthiouron was next insecticide which found very effective against adult whitefly. Hanif *et al*. [12] tested toxicity of three new chemistry insecticides *i.e* fenpropathrin 30 EC (Danitol), pyriproxyfen 10.8 EC (Priority) and diafenthiuron 500 SC (Polo) against cotton whitefly (*Bemesia tabaci*) under laboratory conditions. Mortality was recorded after 24 hours. Pyriproxyfen was recorded to be more toxic with LC_{50} of 133.28 ppm followed by fenpropathrin and diafenthiuron with LC_{50}'s of 361.79 ppm and 4146.95 ppm respectively.

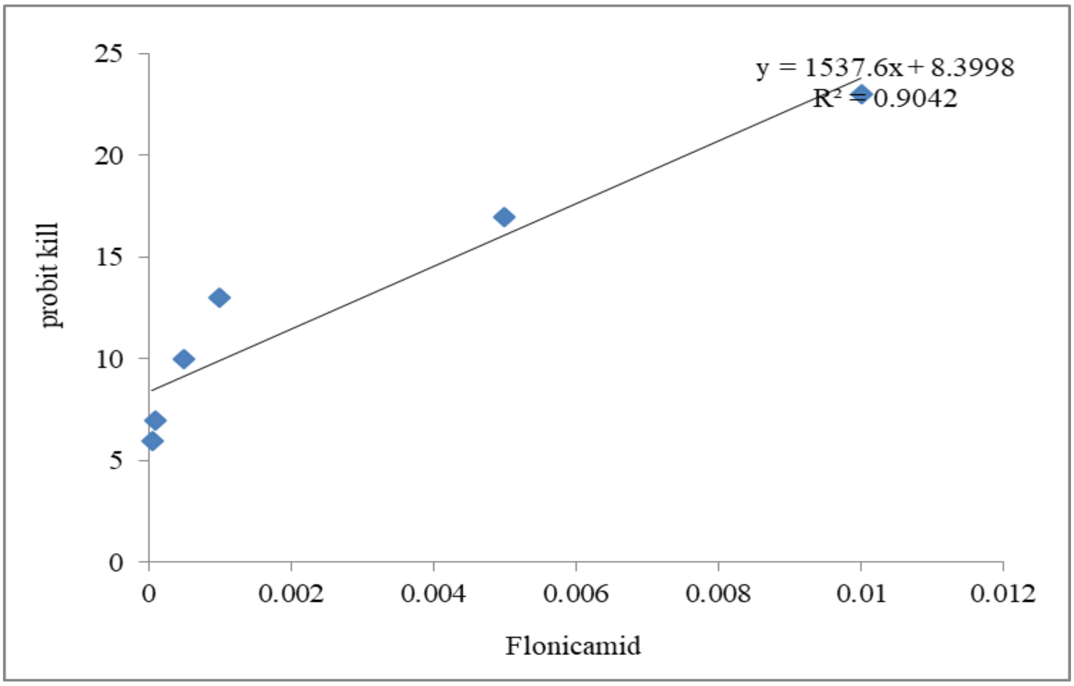
Similarly, Ishaaya *et al.* [13] who reported that diafenthiuron reduces progeny development of the whitefly which also supported to our study. Bacci *et al.* [2] used seventeen insecticides against sweet potato adult whitefly and found that cartap and imidacloprid at 50 and 100% FR and abamectin and acetamiprid at 100% FR showed insecticidal activity to *B. tabaci* adults after 24 h treatment. In our study we found that LC_{50} of flonicamid and spiromesifen insecticides found at par to each other and gave high mortality rate of adult whitefly in range of 22 to 60 and 25 to 65 per cent respectively. Bi and Toscano [4] reported that spiromesifen at 0.5 and 1.0 μg·mL^{-1} a.i. inhibited egg hatching by 80% and 100%, respectively, whereas at concentrations of 3.1, 3.0, and 10.0 μg·mL^{-1} a.i., this insecticide, respectively, killed 100% of the first, second, and third instar nymphs of whitefly which is also agreement to our study.

Table 1: Relative toxicity of insecticides against adult whiteflies on the basis of LC_{50} values

Sl. No.	Insecticide	No. Of whiteflies	LC_{50}	Lower FL	Upper FL	Relative toxicity of LC_{50}	Regression equation	Chi-square
1	Imidacloprid	30	6.6	1.96	46.94	1075.71	Y = 0.138x + 12.04	0.18
2	Flonicamid	30	24.85	9.07	356.67	285.71	Y = 0.1538x + 8.39	0.08
3	Spiromesifen	30	28.37	9.43	839.73	250.26	Y= 0.1532x + 8.41	0.50
4	Diafenthiouron	30	22.59	7.63	581.19	314.29	Y = 0.15382x + 9.1	0.26
5	Dimetheoate	30	7100	2033	9870	1	Y = 0.0014x + 4.12	0.24

*FL; Fiducial limit





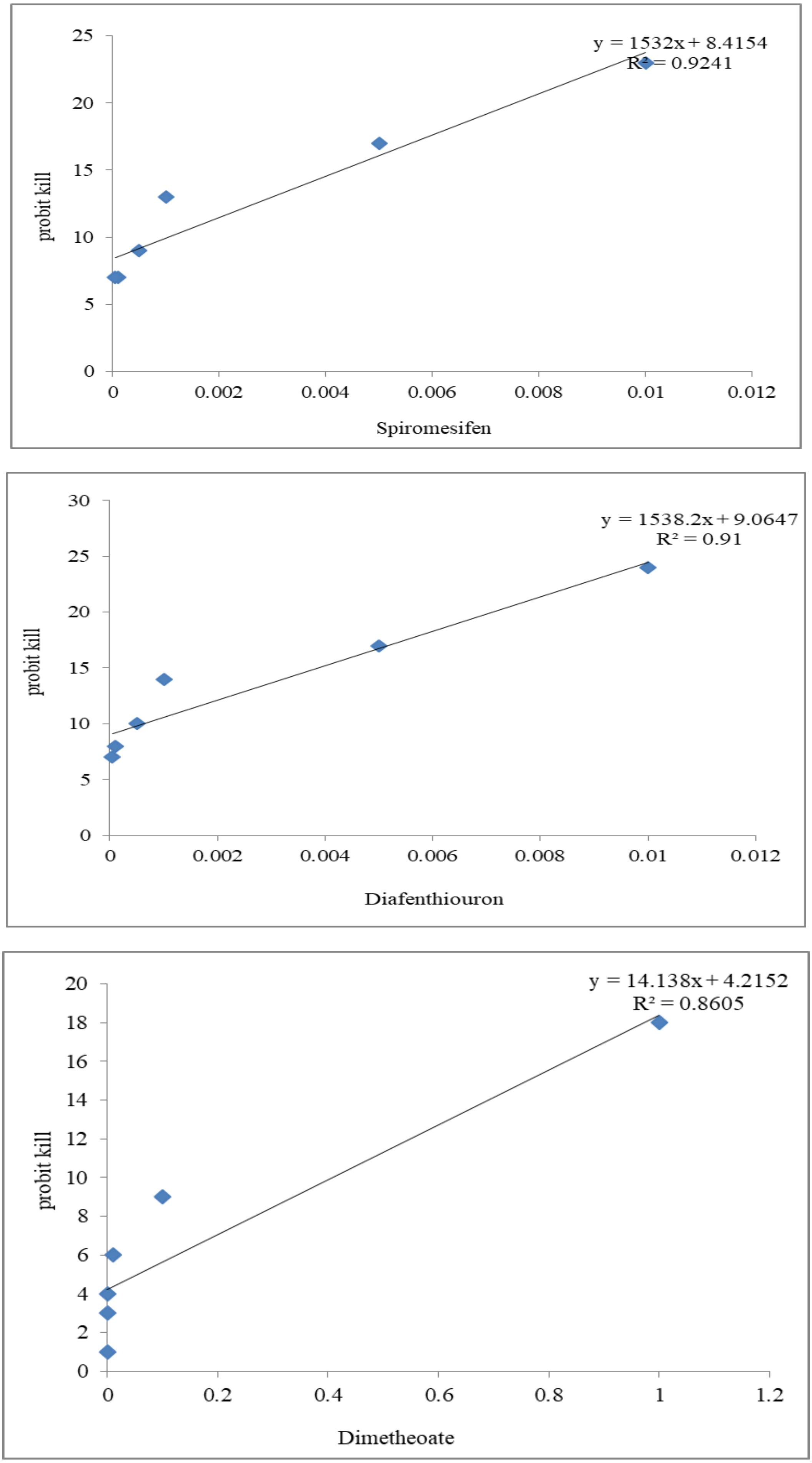


Fig 1: Probit mortality regression lines for different insecticides against adult whiteflies

4. Conclusion

From the present study, it can be concluded that, imidacloprid was found most toxic (LC_{50}-6.6 ppm) to adult whiteflies followed by diafenthiouron (LC_{50}-22.59 ppm) after 24 hours treatment and emerged as best insecticides for managing the whiteflies. These insecticides could be used by kenaf crop growing farmers who completely rely on chemical for management of whitefly and virus.

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6. Conflict of Interest Statement: They have no conflict of interest

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