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Dose response assessment of selected insecticides against *Aphis gossypii* Glover infesting *Bt* cotton under laboratory condition

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ABSTRACT

The cotton aphid (*Aphis gossypii* Glover) has emerged as major sucking pest in *Bt* cotton, exhibiting resistance to diverse chemical classes. This study evaluated the dose-response toxicity of eight insecticides against *A. gossypii* nymphs using the leaf-dip bioassay method under laboratory conditions. Mortality was recorded at 72 hours post-treatment and analysed using probit analysis. Based on median lethal concentration (LC_{50}) values, toxicity followed the descending order: acetamiprid 20 SP (0.002%) > thiamethoxam 25 WG (0.004%) > fipronil 5 SC (0.005%) > clothianidin 50 WDG (0.006%) > flonicamid 50 WG (0.007%) > tolfenpyrad 15 EC (0.020%) > diafenthiuron 50 WP (0.037%) > afidopyropen 50 g/L DC (0.051%). Acetamiprid 20 SP exhibited the highest insecticidal toxicity with a toxicity level 25.50 fold greater than that of afidopyropen 50 g/L DC, the list toxic insecticide evaluated. These baseline toxicological findings provide essential insights for designing rotational chemical strategies and effective management of insecticides resistance in *Bt* cotton ecosystems.

KEY WORDS: Aphid, bioassay, LC_{50}, dose, mortality

INTRODUCTION

Cotton, known as "King of Fibre"and the "white gold", belongs to the family *Malvaceae* and the genus *Gossypium*. Cotton is an important natural fibre crop,besides providing natural fibre, cotton also serves as an oilseed crop. It is cultivated in more than 80 countries.India is the only country that commercially cultivates all four cultivated species of cotton, along with their intra and inter-specific hybrids. *Gossypium hirsutum* accounts for about 90 per cent of hybrid cotton production in India, including all currently cultivated *Bt* cotton hybrids. Cotton is mainly grown in three zones of India, with nearly 70 per cent of the crop cultivated under rainfed conditions(Chaudhary and Gaur, 2011).The major cotton growing countries were India, USA, China, Pakistan and Brazil. (Anon., 2023[a]). During 2022-23, India produced 336.60 lakh bales of cotton from an area of 129.27 lakh hectares and productivity of 442.65 kg/ha. Maharashtra, Gujarat, Andhra Pradesh and Telangana together contribute nearly two-thirds of India's total cotton production and are known as the "Cotton Basket of India". In Gujarat, cotton was cultivated over 24.84 lakh hectares with a production of 87.95 lakh bales with productivity of 601.91 kg/ha, with Surendranagar, Amreli and Rajkot being among the major cotton-producing districts (Anon., 2023[b]). In India, over 160 species of insect pests have been reported damaging to cotton crop (Agrawal, 1978). Bollworms were historically among the most destructive insect pests of cotton, causing about 31 per cent loss in cotton production (Grover and Pental, 2003) and potentially more than 80 per cent crop loss (Oerke, 2005). However, following the introduction of *Bt* cotton in India in 2002, bollworm damage was considerably reduced, while sucking pests that were previously considered minor pests became economically important. Major sucking pests such as leafhopper, aphid, whitefly, mite, thrips, mirid bug, red cotton bug, dusky cotton bug and mealybug can cause significant yield losses in cotton (Thakare *et al*., 1983). Although transgenic *Bt* cotton has effectively suppressed bollworms, particularly *Helicoverpa armigera*, it has not

provided effective resistance against major sucking pests such as aphids, jassids, whiteflies and thrips (Arshad and Suhail, 2010; Hofs*et al*., 2004; Sharma and Pampapathy, 2006).The development of insecticide resistance in cotton aphid is influenced by indiscriminate and repeated use of insecticides, continuous application of a single insecticide group, use of excessive doses and improper application practices. The cotton aphid, *Aphis gossypii*, is an economically important pest that has developed resistance to several broad-spectrum insecticide groups, including organophosphates, pyrethroids, carbamates and neonicotinoids (Herron and Willson, 2011; Shang *et al.*, 2012; Chen *et al.*, 2017). Its short life cycle and high reproductive potential further enhance its ability to develop insecticide resistance (Shi *et al.*, 2011). Resistance-detection bioassays help assess the efficacy of insecticides against field populations and support the selection of effective alternative molecules for sustainable pest management.

MATERIALS AND METHODS

Studies on bioassay of different insecticides against aphid in *Bt* cotton was carried out in the laboratory of Department of Entomology, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar. Four concentrations of each treatment were taken and it was replicated thrice to evaluate the LC_{50}.

Under laboratory conditions, eight insecticidal treatments were evaluated against aphids in *Bt* cotton across four concentration levels: 50% lower dose, 25% lower dose, standard dose, and 25% higher dose. Specifically, Acetamiprid 20 SP was tested at 0.0020%, 0.0030%, 0.0040% (standard) and 0.0050%, Fipronil 5 SC at 0.0050%, 0.0075%, 0.0100% (standard) and 0.0125%, Afidopyropen 50 g/L DC at 0.0500%, 0.0750%, 0.1000% (standard) and 0.1250%, Thiamethoxam 25 WG at 0.0037%, 0.0056%, 0.0075% (standard) and 0.0093%, Diafenthiuron 50 WP at 0.0300%, 0.0450%, 0.0600% (standard) and 0.0750%, Flonicamid 50 WG at 0.0075%, 0.0112%, 0.0150% (standard) and 0.0187%, Clothianidin 50 WDG at 0.0050%, 0.0075%, 0.0100% (standard) and 0.0125% and Tolfenpyrad 15 EC at doses of 0.0150%, 0.0225%, 0.0300% (standard) and 0.0375%.

Preparation of test concentration

Before conducting the laboratory bioassay, insecticide dilutions were prepared to obtain a concentration range causing 10-90 per cent mortality of aphids. Four concentrations of each insecticide were selected within this range and used to determine the median lethal concentration (LC_{50}).

Leaf dip method of bioassay

The insecticidal activity of the test insecticides was evaluated in terms of lethal toxicity using the leaf-dip bioassay method described by Erdogan *et al*. (2012) and Ashrafju *et al*. (2014) against the nymphal stage of aphids. For each treatment, 10 nymphs were released into clean, dry plastic Petri dishes containing filter paper and the experiment was replicated three times. Before treatment, the aphids were starved for 2–3 hours. Fresh cotton leaves were dipped in the respective insecticide concentrations for 30 seconds, shade-dried and placed in the Petri dishes as a food source. In the control, leaves were treated with distilled water only. Mortality was recorded at 24, 48 and 72 hours after treatment, with control mortality recorded simultaneously. Aphids were considered dead when they were desiccated, showed a shortened body and darkened cuticle and failed to exhibit coordinated movement when disturbed with a camel hair brush. The corrected mortality was calculated using Abbott's (1925) formula.

$$\text{Corrected mortality (\%)} = \frac{\text{Mortality in treatment (\%)} - \text{Mortality in control (\%)}}{100 - \text{Mortality in control (\%)}} \text{ X } 100$$

The mortality data was subjected to probit analysis as per method given by Finney (1971) and LC_{50} and LC_{90} values were calculated. For probit analysis, 72 hours mortality data was considered.

RESULTS AND DISCUSSION

Results of laboratory bioassay of eight insecticides *viz.,* acetamiprid 20 SP, fipronil 5 SC, afidopyropen 50 g/L DC, thiamethoxam 25 WG, diafenthiuron 50 WP, flonicamid 50 WG, clothianidin 50 WDG and tolfenpyrad 15 EC using leaf dip method against cotton aphid, A. gossypii.

Acetamiprid 20 SP

Leaf-dip bioassays using cotton leaves treated with acetamiprid 20 SP at concentrations ranging from 0.0020 to 0.0050 per cent resulted in mortality of *A. gossypii* ranging from 53.33 to 90.00 per cent. No mortality was observed in the untreated control. Following correction of the mortality data using Abbott's formula and subsequent probit analysis, the median lethal concentration (LC_{50}) was estimated at 0.002 per cent, with lower and upper fiducial limits of 0.001

and 0.003 per cent, respectively. The concentration of a*cetamiprid 20 SP* required to kill 90 per cent of the test population was estimated to be 0.005 per cent with 0.003 and 0.008 per cent being its fiducial limits. The goodness-of-fit analysis indicated no significant heterogeneity in the data, as the calculated chi-square value (χ^2_{tab}: 0.007) was lower than the tabulated value (χ^2_{cal}: 7.82) at the 5per cent significance level with 3 degrees of freedom.

Table 1: Response of acetamiprid 20 SP on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0020	-2.699	53.33	53.33	0.084	0.086
0.0030	-2.523	73.33	73.33	0.623	0.612
0.0040	-2.398	83.33	83.33	0.967	0.984
0.0050	-2.301	90.00	90.00	1.282	1.273
Untreated control	-	0.00	-	-	-
χ^2_{cal}	=	0.007			
LC_{50} (Fiducial limits) %	=	0.002 (0.001 – 0.003)			
LC_{90} (Fiducial limits) %	=	0.005 (0.003 – 0.008)			

Fipronil 5 SC

The bioassay was conducted by exposing *A. gossypii* to cotton leaves treated with fipronil 5 SC using the leaf-dip method at concentrations ranging from 0.0050 to 0.0125 per cent. The corresponding mortality data are presented in Table 2. Fipronil 5 SC exhibited concentration-dependent toxicity against *A. gossypii*, with mortality ranging from 50.00 to 90.00 per cent, whereas 3.33 per cent mortality was recorded in the untreated control. Probit analysis of the mortality data yielded an LC_{50} value of 0.005 per cent, with lower and upper fiducial limits of 0.004 and 0.008 per cent, respectively. The estimated LC_{90} value was 0.013 per cent, with corresponding lower and upper fiducial limits of 0.009 and 0.019 per cent, respectively. The chi-square test indicated that the data exhibited no significant heterogeneity, as the calculated chi-square value (χ^2 = 0.234) was lower than the tabulated value (χ^2 = 7.82) at the 5 per cent significance level with 3 degrees of freedom.

Table 2: Response of fipronil 5 SC on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0050	-2.301	50.00	48.28	-0.043	-0.087
0.0075	-2.125	66.67	65.52	0.399	0.495
0.0100	-2.000	83.33	82.76	0.945	0.908
0.0125	-1.903	90.00	89.66	1.262	1.228
Untreated control	-	3.33	-	-	-
χ^2_{cal}	=	0.234			
LC_{50} (Fiducial limits) %	=	0.005 (0.004 – 0.008)			
LC_{90} (Fiducial limits) %	=	0.013 (0.009 – 0.019)			

Afidopyropen 50 g/L DC

Under laboratory conditions, cotton leaves treated with different concentrations (0.0500 to 0.1250 %) of afidopyropen 50 g/L DC were offered to *A.gossypii* for bioassay studies, following the methodology described in Section 3.3.2. The observed and corrected mortality ranged from 0.00 per cent in the untreated control, where leaves were treated with distilled water, to 93.33 per cent at a concentration of 0.1250 per cent. After correcting the mortality data using Abbott's formula, probit analysis was performed to estimate the median lethal concentration (LC_{50}), which was found to be 0.051 per cent, with lower and upper fiducial limits of 0.035 and 0.074 per cent, respectively. The LC_{90} value was estimated at 0.118 per cent,

with corresponding lower and upper fiducial limits of 0.082 and 0.171 per cent, respectively (Table 4). The probit mortality response (Y) showed a linear relationship with the logarithm of concentration (X). The chi-square test indicated no significant heterogeneity in the data, as the calculated chi-square value (χ^2_{cal}: 1.637) was lower than the tabulated value (χ^2_{tab}: 7.82) at p = 0.05 and 3 degrees of freedom.

Table 4: Response of afidopyropen 50 g/L DC on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0500	-1.301	53.33	53.33	0.084	-0.032
0.0750	-1.125	63.33	63.33	0.341	0.587
0.1000	-1.000	86.67	86.67	1.111	1.026
0.1250	-0.903	93.33	93.33	1.501	1.366
Untreated control	-	0.00	-	-	-
χ^2_{cal}	=	1.637			
LC_{50} (Fiducial limits) %	=	0.051 (0.035 – 0.074)			
LC_{90} (Fiducial limits) %	=	0.118 (0.082 – 0.171)			

Thiamethoxam 25 WG

Cotton leaves treated with thiamethoxam 25 WG at concentrations ranging from 0.0037 to 0.0093 per cent were offered to *A. gossypii* through the leaf-dip method, resulting in mortality ranging from 46.67 to 83.33 per cent. In contrast, no mortality was observed in the untreated control, where distilled water was used.

Table 5: Response of thiamethoxam 25 WG on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0037	-2.432	46.67	46.67	-0.084	-0.131
0.0056	-2.252	60.00	60.00	0.253	0.329
0.0075	-2.125	73.33	73.33	0.623	0.654
0.0093	-2.032	83.33	83.33	0.967	0.893
Untreated control	-	0.00	-	-	-
χ^2_{cal}	=	0.241			
LC_{50} (Fiducial limits) %	=	0.004 (0.003 – 0.007)			
LC_{90} (Fiducial limits) %	=	0.013 (0.008 – 0.021)			

Following correction of the mortality data using Abbott's formula, probit analysis was performed to determine the median lethal concentration, which was estimated to be 0.004 per cent, with lower and upper fiducial limits of 0.003 and 0.007 per cent, respectively. The LC_{90} value of thiamethoxam 25 WG was estimated at 0.013 per cent, with corresponding lower and upper fiducial limits of 0.008 and 0.021 per cent, respectively (Table 5). The chi-square test indicated no significant heterogeneity in the data, as the calculated chi-square value (χ^2_{cal}: 0.241) was lower than the tabulated value (χ^2_{tab}: 7.82) at 5 per cent rejection level and 3 degrees of freedom.

Diafenthiuron 50 WP

Cotton leaves treated with diafenthiuron 50 WP at concentrations ranging from 0.0300 to 0.0750 per cent were offered to *A. gossypii*, resulting in mortality ranging from 43.33 to 83.33 per cent. In the untreated control, 3.33 per cent mortality was recorded. Probit analysis of the mortality data yielded LC_{50} and LC_{90} values of 0.037 and 0.102 per cent, respectively (Table 6). The probit kill exhibited a linear relationship with the logarithm of concentration. Furthermore, the data were found to be homogeneous, as the calculated chi-square value (χ^2_{cal}: 0.088) was lower than the tabulated value (χ^2_{tab}: 7.82) at 5 per cent rejection level and 3 degrees of freedom.

Table 6: Response of diafenthiuron 50 WP on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0300	-1.523	43.33	41.38	-0.218	-0.246
0.0450	-1.347	60.00	58.62	0.218	0.260
0.0600	-1.222	73.33	72.41	0.595	0.619
0.0750	-1.125	83.33	82.76	0.945	0.898
Untreated control	-	3.33	-	-	-
χ^2_{cal}	=	0.088			
LC_{50} (Fiducial limits) %	=	0.037 (0.024 – 0.055)			

Flonicamid 50 WG

Adults of *A. gossypii* exposed to cotton leaves treated with flonicamid 50 WG at concentrations ranging from 0.0075 to 0.0187 per cent exhibited mortality ranging from 60.00 to 96.67 per cent, whereas 3.33 per cent mortality was recorded in the untreated control. Following correction of the mortality data using Abbott's formula, probit analysis was performed to estimate the median lethal concentration (LC_{50}), which was found to be 0.007 per cent, with lower and upper fiducial limits of 0.005 and 0.010 per cent, respectively. The LC_{90} value of flonicamid 50 WG was estimated to be 0.015 per cent, with corresponding lower and upper fiducial limits of 0.010 and 0.022 per cent, respectively (Table 7). The chi-square test revealed no significant heterogeneity in the data, as the calculated chi-square value (χ^2_{cal}: 0.419) was lower than the tabulated value (χ^2_{tab}: 7.82) at 5 per cent rejection level and 3 degrees of freedom.

Table 7: Response of flonicamid 50 WG on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0075	-2.125	60.00	58.62	0.218	0.162
0.0112	-1.951	76.67	75.86	0.702	0.814
0.0150	-1.824	90.00	89.66	1.262	1.290
0.0187	-1.728	96.67	96.55	1.819	1.648
Untreated control	-	3.33	-	-	-
χ^2_{cal}	=	0.419			
LC_{50} (Fiducial limits) %	=	0.007 (0.005 – 0.010)			
LC_{90} (Fiducial limits) %	=	0.015 (0.010 – 0.022)			

Clothianidin 50 WDG

Cotton leaves treated with clothianidin 50 WDG at concentrations ranging from 0.0050 to 0.0125 per cent were offered to *A. gossypii* through the leaf-dip method, resulting in mortality ranging from 43.33 to 83.33 per cent. In contrast, no mortality was observed in the untreated control, where distilled water was used.

Table 8: Response of clothianidin 50 WDG on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0050	-2.301	43.33	43.33	-0.168	-0.197
0.0075	-2.125	60.00	60.00	0.253	0.297
0.0100	-2.000	73.33	73.33	0.623	0.647
0.0125	-1.903	83.33	83.33	0.967	0.919
Untreated control	-	0.00	-	-	-
χ^2_{cal}	=	0.093			
LC_{50} (Fiducial limits) %	=	0.006 (0.004 – 0.009)			
LC_{90} (Fiducial limits) %	=	0.017 (0.011 – 0.026)			

Following correction of the mortality data using Abbott's formula, probit analysis was carried out to estimate the median lethal concentration (LC_{50}), which was found to be 0.006 per cent, with lower and upper fiducial limits of 0.004 and 0.009 per cent, respectively. The LC_{90} value of clothianidin 50 WDG was estimated at 0.017 per cent, with corresponding lower and upper fiducial limits of 0.011 and 0.026 per cent, respectively (Table 8). The probit kill (Y) exhibited a linear relationship with the logarithm of concentration (X). The chi-square test revealed no significant heterogeneity in the data, as the calculated chi-square value (χ^2_{cal}: 0.093) was lower than the tabulated value (χ^2_{tab}: 7.82) at p = 0.05 and 3 degrees of freedom.

Tolfenpyrad 15 EC

The same methodology was adopted for conducting bioassay studies with all the insecticides. Cotton leaves treated with tolfenpyrad 15 EC at concentrations ranging from 0.0150 to 0.0375 per cent were offered to *A. gossypii*, resulting in mortality ranging from 40.00 to 83.33 per cent. In the untreated control, where *A. gossypii* was fed on cotton leaves dipped only in distilled water, 3.33 per cent mortality was recorded. Probit analysis of the mortality data yielded LC_{50} and LC_{90} values of 0.020 and 0.052 per cent, respectively (Table 9). The probit kill exhibited a linear relationship with the logarithm of concentration. The data were found to be homogeneous, as the calculated chi-square value (χ^2_{cal}: 0.545) was lower than the tabulated value (χ^2_{tab}: 7.82) at 5 per cent rejection level and 3 degrees of freedom.

Table 9: Response of tolfenpyrad 15 EC on mortality of aphid in *Bt* cotton

Conc. (%)	Log (Conc.)	Observed mortality (%)	Corrected mortality (%)	Empirical probit	Expected probit
0.0150	-1.824	40.00	37.93	-0.307	-0.383
0.0225	-1.648	53.33	51.72	0.043	0.156
0.0300	-1.523	70.00	68.97	0.495	0.539
0.0375	-1.426	83.33	82.76	0.945	0.836
Untreated control	-	3.33	-	-	-
χ^2_{cal}	=	0.545			
LC_{50} (Fiducial limits) %	=	0.020 (0.014 – 0.030)			
LC_{90} (Fiducial limits) %	=	0.052 (0.036 – 0.077)			

Relative toxicity of insecticides against *A. gossypii*by leaf dip method

Table 10: Relative toxicity of insecticides against aphid in *Bt* cotton by leaf dip method

Sr. No	Treatments	LC_{50} (%)	Lower fiducial limits (%)	Upper fiducial limits (%)	χ^2_{cal}	Relative toxicity
1.	Acetamiprid 20 SP	0.002	0.001	0.003	0.007	25.50
2.	Thiamethoxam 25 WG	0.004	0.003	0.007	0.241	12.75
3.	Fipronil 5 SC	0.005	0.004	0.008	0.234	10.20
4.	Clothianidin 50 WDG	0.006	0.004	0.009	0.093	8.50
5.	Flonicamid 50 WG	0.007	0.005	0.010	0.419	7.29
6.	Tolfenpyrad 15 EC	0.020	0.014	0.030	0.545	2.55
7.	Diafenthiuron 50 WP	0.037	0.024	0.055	0.088	1.38
8.	Afidopyropen 50 g/L DC	0.051	0.035	0.074	1.637	1.00

Based on the LC_{50} values, the insecticides exhibited the following order of toxicity against *A.gossypii*: acetamiprid 20 SP > thiamethoxam 25 WG > fipronil 5 SC > clothianidin 50 WDG >flonicamid 50 WG >tolfenpyrad 15 EC >diafenthiuron 50 WP >afidopyropen 50 g/L DC, with corresponding LC_{50} values of 0.002, 0.004, 0.005, 0.006, 0.007, 0.020, 0.037 and 0.051 per cent, respectively. Among the insecticides evaluated, acetamiprid 20 SP exhibited the highest toxicity against *A. gossypii* and was approximately 25.50 times more toxic than afidopyropen 50 g/L DC, which was found to be the least toxic insecticide (Table 10).

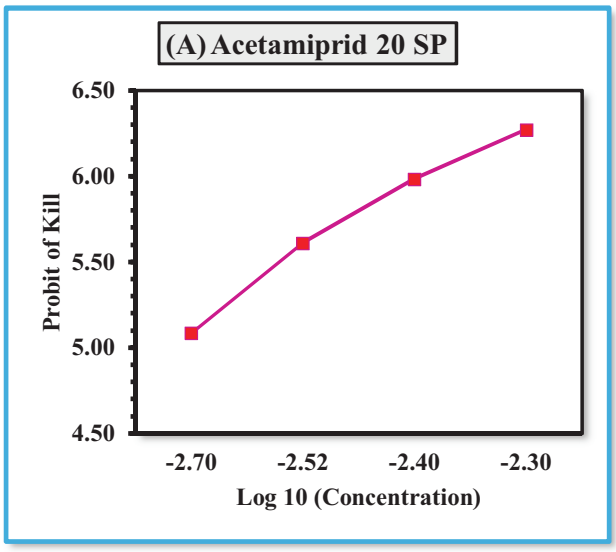
The findings of the present study are consistent with those reported by Awasthi *et al.* (2013), who investigated the relative toxicity of six insecticides against cotton aphid, *A. gossypii*. Based on LC_{50} values, acetamiprid exhibited the highest toxicity against the aphid, whereas spinosad recorded the highest LC_{50} value and was considered the least toxic insecticide. Considering the relative toxicity of spinosad as unity, the insecticides were ranked in the following order: acetamiprid >acephate> imidacloprid >emamectin benzoate > indoxacarb, with corresponding relative toxicity values of 82.28, 23.04, 16.18, 1.57 and 1.45, respectively. Similarly, Abd-Ella (2014) assessed the toxicity of neonicotinoid insecticides against cowpea aphid using the leaf-dip bioassay method and reported that thiamethoxam, acetamiprid and imidacloprid exhibited the highest aphicidal activity, with LC_{50} values of 0.60, 0.71 and 1.16 mg/L, respectively. In contrast, dinotefuran showed the lowest toxicity, with an LC_{50} value of 23.41 mg/L. These results demonstrated the high efficacy of neonicotinoid insecticides against cowpea aphid under laboratory conditions.

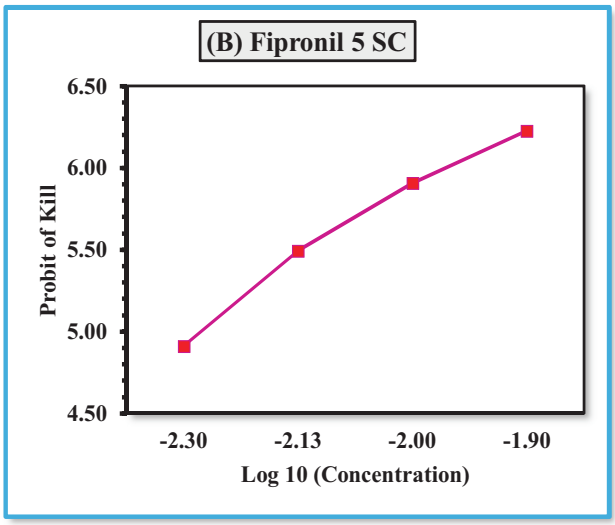
CONCLUSION

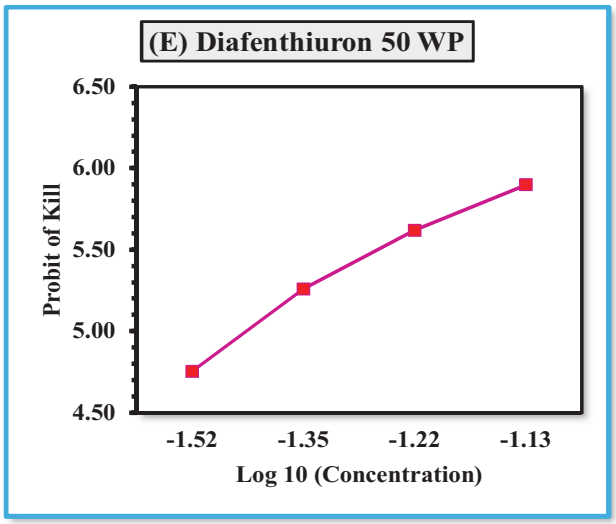
Among the eight tested insecticides, acetamiprid 20 SP exhibited the highest toxicity against *Aphis gossypii*, followed by thiamethoxam, fipronil, clothianidin, and flonicamid, while afidopyropen was the least toxic. These dose–response baselines support selecting potent chemistries and rotating diverse modes of action to manage insecticide resistance effectively in *Bt* cotton.

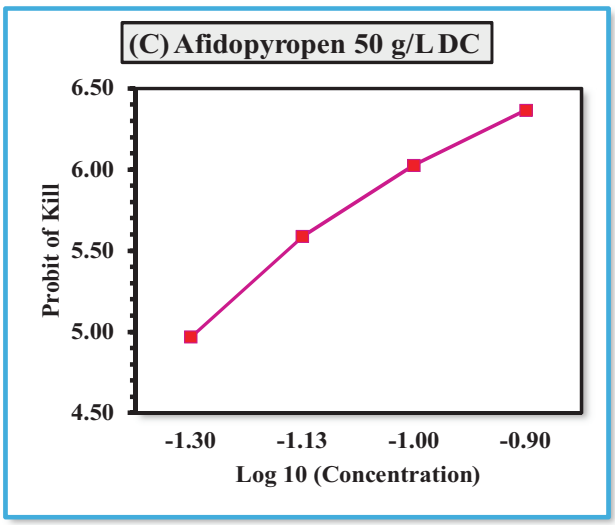
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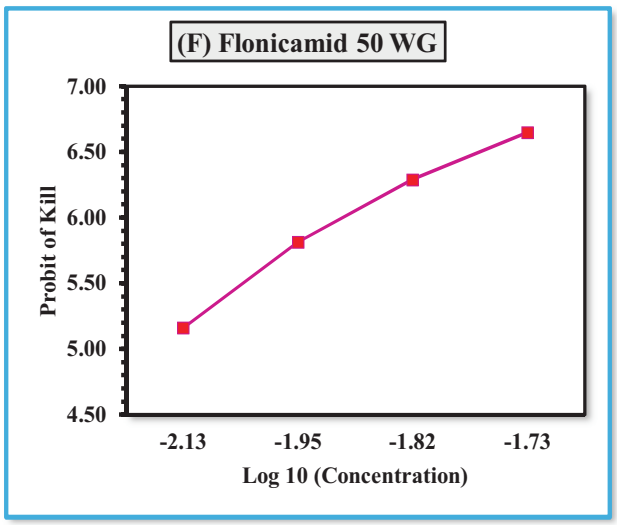
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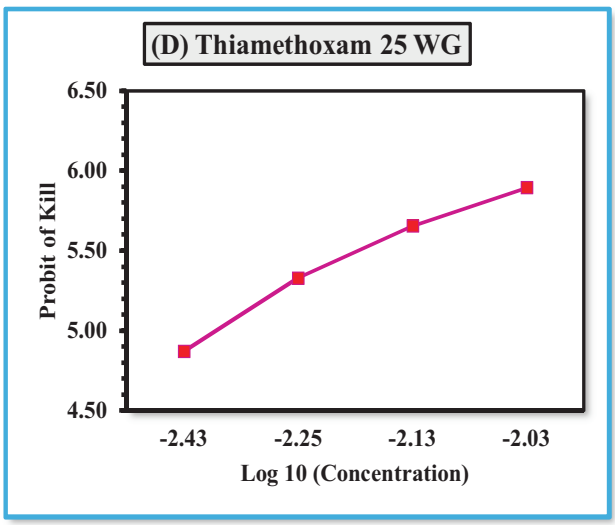


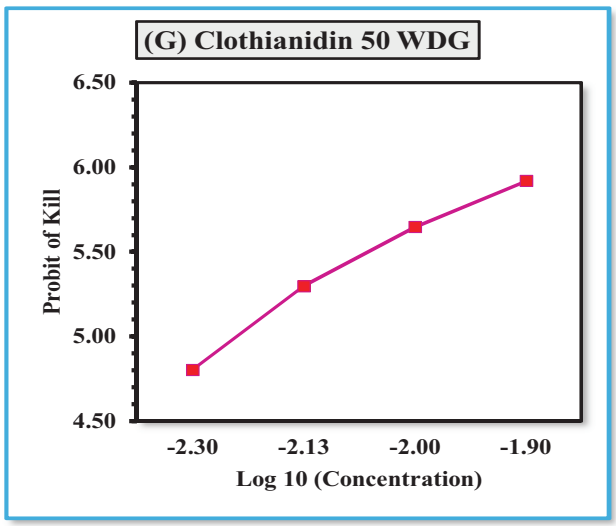

(B) Fipronil 5 SC
Probit of Kill
6.50
6.00
5.50
5.00
4.50
-2.30
-2.13
-2.00
-1.90
Log 10 (Concentration)

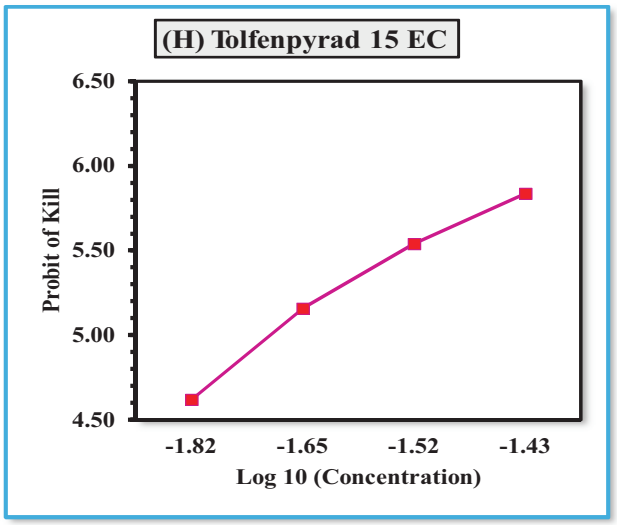

(E) Diafenthiuron 50 WP
Probit of Kill
6.50
6.00
5.50
5.00
4.50
-1.52
-1.35
-1.22
-1.13
Log 10 (Concentration)


(C) Afidopyropen 50 g/L DC
Probit of Kill
6.50
6.00
5.50
5.00
4.50
-1.30
-1.13
-1.00
-0.90
Log 10 (Concentration)


(F) Flonicamid 50 WG
Probit of Kill
7.00
6.50
6.00
5.50
5.00
4.50
-2.13
-1.95
-1.82
-1.73
Log 10 (Concentration)


(D) Thiamethoxam 25 WG
Probit of Kill
6.50
6.00
5.50
5.00
4.50
-2.43
-2.25
-2.13
-2.03
Log 10 (Concentration)


(G) Clothianidin 50 WDG
Probit of Kill
6.50
6.00
5.50
5.00
4.50
-2.30
-2.13
-2.00
-1.90
Log 10 (Concentration)



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