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TOXICITY OF COMMONLY USED CHEMICAL INSECTICIDES ON MANGO HOPPER

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ABSTRACT

Mango production in Bangladesh is enormously affected by the infestation of hopper which punctures and sucks sap from tender shoots, inflorescences, and leaves of mango tree, causing non-setting of fruits and dropping of immature fruits. Control of mango hopper in recent days is solely done by synthetic insecticides. This study was conducted in the laboratory during January to October 2022 to know the toxicity of four commonly used insecticides, namely Desis 2.5 EC (Deltamethrin), Ripcord 10 EC (Cypermethrin), Relothrin 10 EC (Cypermethrin), and Sumithion 50 EC (Fenitrothion) on mango hopper. The doses of Desis 2.5 EC, Ripcord 10 EC and Relothrin 10 EC were prepared as 1200, 1000, 750, 500 and 100 ppm, and Sumithion 50 EC solutions were 2500, 2200, 1500, 1000 and 500 ppm. Results showed that the tested insecticides with their recommended doses revealed 51.4±2.5 to 70.6±1.8% mortality of hopper at 4 hours after treatment where Desis 2.5 EC showed the highest mean mortality of the insect. Desis 2.5 EC also showed the lowest LC_{50} and LC_{95} values (426.0 and 4331.4 ppm, respectively at 4 hours after treatment) signifying its higher effectiveness compared to other tested insecticides.

Keywords: Hopper, *Mangifera indica*, mortality, synthetic insecticides, toxicity

INTRODUCTION

Mango *Mangifera indica* L. is considered as of one of the most popular fruits in Bangladesh in terms of its production and consumption. However, the yield of mango in Bangladesh is significantly low because of the infestation of the sucking insect namely hopper (Namni *et al*. 2017). Hopper is a widespread and serious pest of mango throughout the country (Adnan *et al*. 2014). Hoppers can be found year-round in the mango orchard, but they are largely abundant at the flowering season. Rainy and foggy weather conditions during February and March play significant role on their population build-up (Rahman and Kuldeep 2007).

The nymph and adult stages of the hopper puncture and suck sap from tender shoots, inflorescences, and leaves of mango tree, which can cause non-setting of fruits and dropping of immature fruits (Shawan *et al.* 2018). They excrete massive quantities of honeydew which encourages the growth of fungi *Capnodium mangiferum* and *Meliola mangiferae* resulting in the growth of sooty mold on dorsal surface of leaves, branches, and fruits (Rahman and Kuldeep 2007). Consequently, hopper infestations severely reduce the yield and quality of mango.

Many synthetic insecticides having different modes of action have been recommended so far by different scientists for the management of mango hopper. Insecticides such as, imidacloprid, lambdacyhalothrin and azadiractin are recommended to save the crop from losses due to mango hopper infestation (Haider and Bakhsh *et al*. 2018). Buprofezin, spinosad, acetamiprid, thiamethoxam, deltamethrin and cypermethrin can also be useful to effectively control of mango hopper. The mango growers in Bangladesh repeatedly apply insecticides of different modes of action singly or combinedly without concerning the effective dose to control hopper. However, the insecticides are toxic, potentially hazardous to humans, animals, other organisms, and the environment. Moreover, repeated use of the same class of insecticides against an insect pest can cause undesirable changes in the gene pool of the pest leading to pesticide resistance.

The toxicity of an insecticide is determined by assessing mortality of the insect pest with varying dosages of the

active ingredient and each of its formulated products. Hence, appropriate dose of an insecticide is important for rapid and long-lasting management of an insect pest. Therefore, the present study was conducted with different doses of very commonly used insecticides, namely Desis 2.5 EC (Deltamethrin), Ripcord 10 EC (Cypermethrin), Sumithion 50 EC (Fenitrothion) and Relothrin 10 EC (Cypermethrin) to test their toxic effects on mango hopper.

Materials and Methods

Insecticide treatments and observation of mortality: Four insecticides, namely Desis 2.5 EC, Ripcord 10 EC, Relothrin 10, EC and Sumithion 50 EC were taken to study their effects on the mortality of hopper at different hours after treatment in the laboratory from January to October 2022. Details of the insecticides are listed in Table 1. Mortality effects of the insecticides were experimented following completely randomized design (CRD). Five concentrations of each treatment were prepared. The doses of Desis 2.5 EC, Ripcord 10 EC and Relothrin 10 EC were prepared as 1200, 1000, 750, 500 and 100 ppm. Sumithion 50 EC solutions were applied at 2500, 2200, 1500, 1000 and 500 ppm. Mango hoppers were collected from the mango orchard using sweep net. Fresh inflorescences were cut from the plant by using scissor. Inflorescences were soaked in the insecticide solutions and was completely dried keeping on tissue paper. After drying, inflorescences were placed in the petri dishes along with the insects. Fifteen mango hoppers were placed in each petri dish. The number of dead insects was counted every hour up to four hours after setting the experiment. Number of dead mango hoppers of each petri dish was recorded and mortality was calculated into percentage. The observed mortality under insecticide treatments was corrected using Schneider-Orelli's formula (Puntener 1981).

Statistical analysis: One-way analysis of variance was done to determine the efficacy of the insecticides on the mortality followed by Tukey HSD posthoc test (at 5% level of significance). Probit analysis was employed for analyzing the dose-mortality response at 95% fiducial confidence interval. LC_{50} and LC_{95} values and their fiducial limits were estimated.

Results and Discussion

The mortality effects of the selected insecticides at their recommended dose on mango hopper after 1, 2, 3 and 4 hours of the treatments are presented in Table 2. The mortality rate among the treatments at 1 and 2 hours after treatment ranged from 35.6±0.0% to 41.6±2.2% and 37.0±0.7% to 45.6±2.8%, respectively. The insecticides at 1 and 2 hours after treatment revealed no statistical differences among the mortalities of mango hopper. The mortality effects of selected insecticides at their recommended dose on mango hopper at 3 hours after treatments revealed significant differences and the mortality data ranged from 44.6±1.2% to 65.0±1.5%. The highest mortality (65.0±1.5%) was found with Desis 2.5 EC which showed statistically similar result with Sumithion 50 EC treated hoppers. On the other hand, the lowest mortality (44.6±1.2%) was found in hopper treated with Relothrin 10 EC. Relothrin 10 EC showed statistically similar result with Ripcord 10 EC. The mortality effects of selected insecticides at their recommended dose on mango hopper at 4 hours after treatments revealed significant differences and the data ranged from 51.4±2.5% to 70.6±1.8%. The highest mortality (70.6±1.8%) was found with Desis 2.5 EC which was statistically similar with Sumithion 50 EC treatment (69.3±2.4%). The lowest mortality (51.4±2.5%) was found with Relothrin 10 EC treated hoppers.

The toxicity of the insecticides at 1 hour after treatment on mango hopper is presented in Table 3. Results revealed

Table 1. Details of the insecticide treatments applied to mango plants for controlling mango hoppers

Trade name	Active ingredient	Recommended dose	Mode of action
Desis 2.5 EC	Deltamethrin	1000 ppm	Direct contact or ingestion
Ripcord 10 EC	Cypermethrin	1000 ppm	Non-systemic insecticide with contact and stomach action
Relothrin 10 EC	Cypermethrin	1000 ppm	Non-systemic insecticide with contact and stomach action
Sumithion 50 EC	Fenitrothion	2200 ppm	Non-systemic insecticide with contact and stomach action, Cholinesterase inhibitor

Table 2. Effects of different insecticides on the mean mortality of hopper at different hours after treatment

Insecticide treatment	Mortality rate (%) at different hours after treatment			
	1 hour	2 hours	3 hours	4 hours
Desis 2.5 EC	41.6 ± 2.2 a	42.4 ± 2.2 a	65.0 ± 1.5 a	70.6 ± 1.8 a
Ripcord 10 EC	36.1 ± 0.7 a	37.0 ± 0.7 a	48.1 ± 3.4 b	58.4 ± 3.9 ab
Relothrin 10 EC	35.6 ± 0.0 a	37.1 ± 2.4 a	44.6 ± 1.2 b	51.4 ± 2.5 b
Sumithion 50 EC	41.1 ± 3.1 a	45.6 ± 2.8 a	61.2 ± 2.4 a	69.3 ± 2.4 a

Means within a column followed by the same letter(s) are not significantly different by Tukey HSD posthoc test at $p \leq 0.05$.

Table 3. Toxicity of the studied insecticides on mango hopper at 1 hour after treatment

Insecticides	Slope (±S.E)	LC_{50} (95% fl)	LC_{95} (95% fl)	χ^2 (df)	P
Desis 2.5 EC	1.2±0.2	1137.3 (889.4-1624.9)	27351.3 (11359.9-134496.4)	5.1(3)	0.165
Ripcord 10 EC	0.9±0.2	2164.5 (1448.0-4661.7)	95150.4 (24719.5-1647192.8)	1.4(3)	0.715
Relothrin 10 EC	1.0±0.2	2141.8 (1436.4-4572.0)	94329.2 (24655.7-1594381.3)	2.9(3)	0.401
Sumithion 50 EC	1.2±0.2	2230.0 (1756.6-3359.2)	54905.2 (19207.1-591123.6)	4.5(3)	0.208

Each datum represents the mean of three replicates. Concentrations are expressed as ppm. fl stands for fiducial limits.

that LC_{50} and LC_{95} values ranged from 1137.3 to 2230.0 and 27351.3 to 95150.4 ppm, respectively. Desis 2.5 EC showed the highest toxicity with the lowest LC_{50} and LC_{95}. Sumithion 50 EC displayed the maximum LC_{50} value and Ripcord 10 EC showed the maximum LC_{95} value. The LC_{50} and LC_{95} of Relothrin 10 EC were 2141.8 and 94329.2 ppm, and of Ripcord 10 EC were 2164.5 and 95150.4 ppm, respectively.

The toxic effects of the insecticides at 2 hours after treatment on mango hopper revealed that LC_{50} and LC_{95} values ranging from 956.6 to 1949.8 and 22421.5 to 53802.4 ppm, respectively (Table 4). Desis 2.5 EC had the minimum LC_{50} and LC_{95} values; therefore, revealed the highest toxicity on mango hopper. Ripcord 10 EC displayed the maximum LC_{50} and LC_{95} values. The LC_{50} and LC_{95} of Relothrin 10 EC were 1831.6 and 50748.1 ppm, respectively.

The toxicity of the insecticides at 3 hours after treatment on mango hopper showed that LC_{50} and LC_{95} values of the tested insecticides against mango hopper ranged from 604.6 to 1278.3 and 6508.9 to 36274.5 ppm, respectively (Table 5). Relothrin 10 EC displayed the maximum LC_{50} value and LC_{95} value. Desis 2.5 EC showed the minimum LC_{50} and LC_{95} values showing the highest toxicity. The LC_{50} and LC_{95} of Ripcord 10 EC were 1140.3 and 34181.9 ppm, and for Sumithion 50 EC they were 1217.8 and 10480.4 ppm, respectively.

The toxicity of the insecticides at 4 hours after treatment on mango hopper is presented in table 6. Results showed that the LC_{50} and LC_{95} values ranging from 426.0 to 998.1 ppm and 4331.4 to 11088.6 ppm, respectively. Desis 2.5 EC showed the minimum LC_{50} and LC_{95} values. Sumithion 50 EC displayed the maximum LC_{50} value and Ripcord 10 EC showed the maximum LC_{95} value. The LC_{50} and LC_{95} of Relothrin 10 EC were 778.3 and 10280.0 ppm, respectively. Therefore, Desis 2.5 EC showed the highest toxicity among the tested insecticides.

The findings of the current study showed that the mortality rate of mango hopper increased with the duration of exposure to the insecticides. Desis 2.5 EC and Sumithion 50 EC showed the highest mortality rate at 3 and 4 hours after treatment, while Relothrin 10 EC and Ripcord 10 EC showed the lowest mortality rate. These results are consistent with the findings of previous research done by Khan *et al*. (2007) and Shahid *et al*. (2019) which found Desis 2.5 EC as the most effective insecticide against mango hoppers. Jing *et al.* (2017) found that Relothrin 10 EC had low toxicity against mango hopper.

Table 4. Toxicity of the studied insecticides on mango hopper at 2 hours after treatment

Insecticides	Slope (±S.E)	LC_{50} (95% fl)	LC_{95} (95% fl)	χ^2 (df)	P
Desis 2.5 EC	1.2±0.2	956.6 (761.4-1296.8)	22421.5 (9878.4-96234.0)	6.0(3)	0.112
Ripcord 10 EC	1.1±0.2	1949.8 (1381.1-3599.7)	53802.4 (17601.8-490668.1)	7.1(3)	0.068
Relothrin 10 EC	1.1±0.2	1831.6 (1314.2-3267.7)	50748.1 (16997.2-432120.3)	5.5 (3)	0.141
Sumithion 50 EC	1.4±0.2	1903.1 (1573.9-2486.3)	28137.2 (13091.0-126556.3)	4.1(3)	0.248

Each datum represents the mean of three replicates. Concentrations are expressed as ppm. fl stands for fiducial limits.

Table 5. Toxicity of the studied insecticides on mango hopper at 3 hours after treatment

Insecticides	Slope (±S.E)	LC_{50} (95% fl)	LC_{95} (95% fl)	χ^2 (df)	P
Desis 2.5 EC	1.6±0.2	604.6 (271.3-1310.6)	6508.9 (2226.1-2542810.4)	12.1(3)	< 0.05
Ripcord 10 EC	1.1±0.2	1140.3 (878.1-1676.4)	34181.9 (13116.2-201486.6)	6.5(3)	0.091
Relothrin 10 EC	1.1±0.2	1278.3 (974.0-1942.1)	36274.5 (13715.8-221984.8)	6.9(3)	0.076
Sumithion 50 EC	1.8±0.2	1217.8 (1033.6-1414.5)	10480.4 (6687.4-22330.2)	7.6(3)	0.054

Each datum represents the mean of three replicates. Concentrations are expressed as ppm. fl stands for fiducial limits.

Table 6. Toxicity of the studied insecticides on mango hopper at 4 hours after treatment

Insecticides	Slope (±S.E)	LC_{50} (95% fl)	LC_{95} (95% fl)	χ^2 (df)	P
Desis 2.5 EC	1.6±0.2	426.0 (113.6-827.7)	4331.4 (1625.4-1279149.6)	14.8(3)	< 0.05
Ripcord 10 EC	1.4±0.2	800.2 (417.6-2838.8)	11088.6 (3007.1-67539984.0)	10.8(3)	< 0.05
Relothrin 10 EC	1.5±0.2	778.3 (453.3-1820.8)	10280.0 (3193.8-2166381.0)	8.3(3)	< 0.05
Sumithion 50 EC	2.0±0.2	998.1 (343.2-1554.9)	6652.3 (3083.1-752749.1)	11.3(3)	< 0.05

Each datum represents the mean of three replicates. Concentrations are expressed as ppm. fl stands for fiducial limits.

The results of this study showed that different insecticides had varying levels of toxicity on mango hoppers at different time intervals after treatment. Desis 2.5 EC displayed the highest toxicity, with the lowest LC_{50} and LC_{95} values. Jing *et al*. (2017) and Sharma *et al*. (2019) also reported that Desis 2.5 EC had high toxicity levels against a variety of insect pests, including mango hopper. However, the study by Khan *et al*. (2007) found Sumithion 50 EC to be the most toxic insecticide, which differed from the findings of this study.

The findings showed that the Desis 2.5 EC at its recommended dose showed higher level of mortality of hopper compared to other insecticides. The mortality rate of this insecticide in laboratory condition at 1 to 4 hours after treatment ranged from 41.6 ±2.2 to 70.6±1.8% which is not satisfactory for effective control of hopper. For effective management of an insect pest, 80% mortality of that pest should be achieved in the lab tests after insecticide application at its recommended dose. However, in the field condition the result may be reduced due to the impact of the weather conditions. So, the findings indicated that the recommended dose of the Desis 2.5 EC and the other tested insecticides are not suitable to control hoper at their recommended doses. The toxicity data revealed that the higher doses of the insecticides may result up to the level of mortality. To achieve 95% mortality in laboratory condition, the application doses of Desis 2.5 EC, Ripcord

10 EC, Relothrin 10 EC and Sumithion 50 EC should be 4331.4, 11088.6, 10280.0 and 6652.3 ppm, respectively. On the other hand, application of the higher doses may cause hazardous effects on pollinator insects and natural enemies of the hopper, and likewise will be costly. The findings predicted that the hopper may have developed resistance over time to the tested insecticides, and new chemicals are necessary for effective management of this pest.

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