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TOXICITY AND EFFECTS OF SOME CHEMICAL INSECTICIDES AND NEEM OIL ON ROSE THRIPS

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ABSTRACT

The study was conducted in the rose garden of the Department of Horticulture and Laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh to assess the toxicity of three synthetic and one botanical insecticides namely Confidor 70 WG, Actara 25 WG, Liquor 1.8 EC and neem oil on rose thrips. The highest mean mortality (75.0 ± 1.9%) of thrips was found with Confidor 70 WG. Besides, Confidor 70 WG showed the lowest value of LC_{50} and LC_{95} (147.6 and 708.3 ppm, respectively at 6 hours after treatments). The findings revealed that the tested insecticides showed significant differences on the leaf and flower infestation against thrips on rose plants and had promising effect in reducing the infestation level. The level of leaf and flower infestation (6.7 ± 3.8% and 9.7 ± 0.5%, respectively) was found the lowest in Confidor 70 WG treated plot.

Keywords: Insecticides, neem oil**,** *Rosa* sp., *Rhipiphorothrips cruentatus*, mortality, infestation.

INTRODUCTION

Rose (*Rosa* sp.) is a very popular ornamental plant and one of the most trading commodities worldwide. Bangladesh is well suited for ornamental crop production due to its favorable climate. There is a much opportunity in the country to expand agriculture on unused homestead lands, low labor costs, low investment, and a promising export market. The rose cultivation area, total production, and average yield in Bangladesh were 269.5 ha, 19193.1 mt and 71.2 t ha^{-1}, respectively in the year 2019-2020 (BBS 2020). But the rose production in Bangladesh is threatened due to infestation of different insect pests. Thrips, aphid and budworm are the major insect pests of rose (Islam *et al*. 2019). Among them, the rose thrips *Rhipiphorothrips cruentatus* (Thysanoptera: Thripidae) suck sap from leaves, flower buds and petals

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cause distorted and deformed flowers that resulted in the reduction of flower quality and yield as well (Flint and Karlik 2008). Proper management of thrips could ensure higher yield and quality of rose. Amin *et al.* (2020) stated that with the increasing demand for cut roses in Bangladesh, it is essential to develop suitable pest management strategies against sucking pests to increase flower quality and yield while reducing management costs and adverse impacts.

The farmers of Bangladesh are mostly dependent on synthetic chemical pesticides to control the sucking pests of ornamental plants. They used pesticides on a regular basis to control insect pests to ensure the attractive flower its size and color. Mostly the farmers use insecticides indiscriminately, and they usually use lower and/or higher pesticide doses and suffer from pest problems (Amin and Islam 2020). There are a variety of modern insecticides in the market nowadays but the farmers are usually looking for quick results of pest control. So, they utilize synthetic pesticides, which leads to pesticides resistance, insect resurgence, environmental pollution, and the destruction of natural pest enemies (Bajya and Ranjith 2016). Therefore, the present study was undertaken to assess the toxicity of some insecticides in laboratory conditions, and the effect of the insecticides on the infestation of thrips on rose leaves and flowers in field plots.

MATERIALS AND METHODS

Experimental conditions: The study was conducted during February to December 2021 in the rose garden of the Department of Horticulture and Laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh. The studied rose garden occupied an area of 60 m × 20 m. There were 30 plots of equal size (10 m × 1 m) in the studied rose garden. Irrigation was provided based on necessity. Pruning was done to ensure sunlight and aeration in the assigned garden. Fertilizers were applied according to fertilizer recommendation guide (FRG 2018). Each of thirty plots contains only one row with 8 plants per row. The distance between plant to plant and row to row maintained 1.0 m and 2.0 m, respectively. From the assigned plots five consecutive plots were considered as a block and thus fifteen plots were selected for insecticide treatments. The treatments were allocated following randomized complete block design with three replications.

Observation on mortality effects of the insecticides in laboratory condition: Experiment on mortality effects of the insecticides was done following completely randomized design (CRD) in the laboratory condition. Five concentrations of each treatment were prepared. The doses of Confidor 70 WG were prepared with 200, 150, 100, 50 and 25 ppm, Actara 25 WG at 250, 200, 150, 100 and 50 ppm, Liquor 1.8 EC at 2000, 1500, 1000, 500 and 250 ppm. Neem oil was applied at 3000, 2500, 2000, 1500 and 1000 ppm. Digital weighing balance was used for measuring water-dispersible granule (WG) insecticides and micropipette for measuring emulsifiable concentrate (EC). Thrips were collected from the rose field using aspirator. Fresh petals and leaves of rose were cut from the plant by using scissor. Petals and leaves were soaked in the solutions and then air dried for 30 minutes and were placed in the petri dishes as the diet of the thrips. Each petri dish contained 20 thrips. Mortality data of the thrips were counted at 2, 4 and 6 hours after treatments (HATs) and calculated mortality rates. The observed mortality of treatments was corrected using Schneider-Orelli's formula according to Puntener (1981).

$$\text{Mortality (\%)} = \frac{\text{Number of dead thrips per Petri dish}}{\text{Number of total thrips per Petri dish}} \times 100$$

$$\text{Corrected mortality (\%)} = \frac{\text{Treatment mortality (\%) - Control mortality (\%)}}{\text{100 - Control (\%)}} \times 100$$

Application of insecticides in the experimental field plots: Tested insecticides (Table 1) were applied viz., Confidor 70 WG (Imidacloprid) @ 0.2 gL^{-1} water, Actara 25 WG (Thiamethoxam) @ 0.25 gL^{-1} water, Liquor 1.8 EC (Abamectin) @ 2.0 mlL^{-1} water and Neem oil @ 3.0 mlL^{-1} water. The control plots were kept free from insecticides. The spray schedule maintained uniformly three times at 10 days intervals with the help of a knapsack sprayer in the morning to avoid bright sunlight and drift caused by wind.

Table 1. Tested insecticides against rose thrips

Trade name	Active ingredient	Recommended dose	Mode of action
Confidor 70 WG	Imidacloprid	200 ppm	Systemic insecticide with contact and stomach action
Actara 25 WG	Thiamethoxam	250 ppm	Systemic insecticide
Liquor 1.8 EC	Abamectin	2000 ppm	Contact
Neem oil	Azadirachtin	3000 ppm	Systemic and contact

Observation of leaf and flower infestations: The number of healthy and infested leaves and flowers of a single shoot from 3 selected plants of each treatment was counted after 2 and 7 days of every spray. The leaf and flower infestation rates were calculated into percentage.

Statistical analysis: One way analysis of variance followed by Tukey's HSD posthoc test (at 5% level of significance) was done to determine the variation of leaf and flower infestation rate. Probit analysis was employed for analyzing the dose-mortality response. LC_{50} and LC_{95} values and their fiducial limits were estimated. Toxicity ratios (TR) were calculated using the formula stated by Gusmao *et al.* (2013). The statistical software package IBM SPSS 20.0 was used for data analysis.

RESULTS AND DISCUSSION

The mortality effect of the laboratory tested insecticides on thrips at 2, 4 and 6 hours after treatments (HATs) are presented in Fig. 1. The mean mortality of thrips at 2 HATs at their recommended doses ranged from 48.0 ± 6.5 to 55.2 ± 1.8% and the results did not show significant variation ($F_{3,8} = 0.6$, $p = 0.61$). The mortality effect at 4 HATs revealed significant differences ($F_{3,8} = 3.9$, $p < 0.05$) and ranged from 49.1 ± 3.3 to 64.2 ± 5.0%. The highest mortality (64.2±5.0%) was found with Confidor 70 WG. Conversely, the lowest mortality (49.1 ± 3.3%) was found with neem oil. The mortality at 6 HATs ranged from 55.8 ± 5.1 to 75.0 ± 1.9% and found significant difference ($F_{3,8} = 7.0$, $p < 0.05$). The highest mortality (75.0 ± 1.9%) was found with Confidor 70 WG. Actara 25 WG (63.5 ± 1.9%) and Liquor 1.8 EC (61.5 ± 1.9%) showed statistically similar mortality. But the lowest mortality (55.8 ± 5.1%) was found with neem oil.

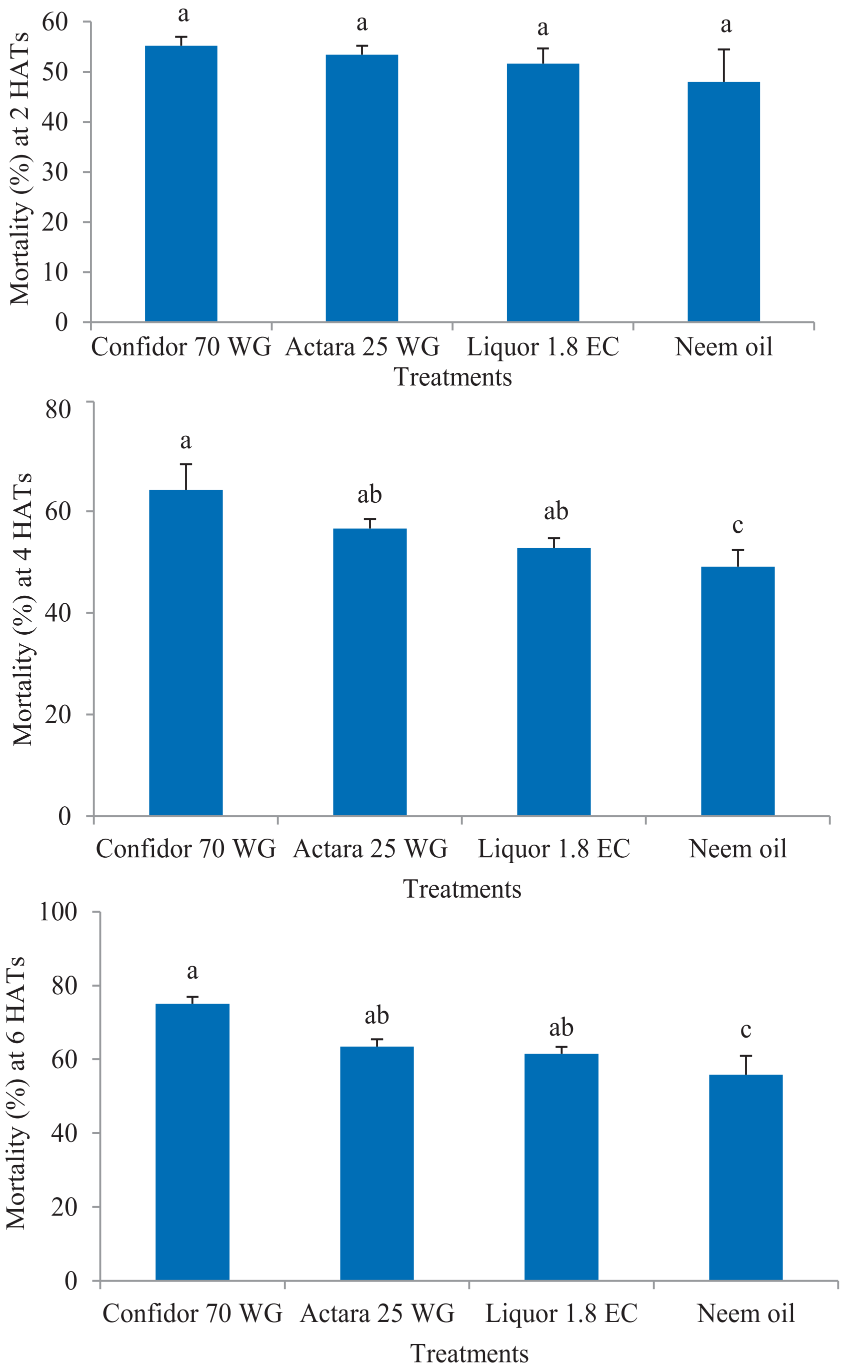

Fig. 1. Effect of different insecticides on the mortality of rose thrips at 2, 4 and 6 HATs.

Toxicity data revealed that LC_{50} and LC_{95} values ranged from 214.3 to 3462.3 and 1412.0 to 9807.6 ppm, respectively (Table 2). Confidor 70 WG showed maximum TR_{50} and TR_{95} (16.2 and 6.9, respectively), while minimum as 1.7 and 1.1 from Liquor 1.8 EC, respectively. The LC_{50} and LC_{95} values ranged from 168.1 to 3403.9 and 1157.1 to 8437.6 ppm, respectively at 4 HATs (Table 3). Confidor 70 WG showed maximum TR_{50} and TR_{95} (20.2 and 7.3, respectively. but minimum as 1.2 and 1.1 from Liquor 1.8 EC, respectively. Toxicity data at 6 HATs revealed that LC_{50} and LC_{95} values ranged from 147.6 to 3010.4 and 708.3 to 6136.9 ppm, respectively (Table 4). Confidor 70 WG showed maximum TR_{50} and TR_{95} (20.4 and 8.7, respectively) while minimum from Liquor 1.8 EC (1.7 and 1.0, respectively). Conversely, Neem oil showed the lowest toxicity on rose thrips at 2, 4 and 6 hours after treatment and the steep slope of concentration response curve indicated that small variations in the concentrations induced greater responses in mortality. According to the current findings, the order of toxicity of different insecticides to rose thrips based on LC_{50} and LC_{95} was imidacloprid > thiamethoxam > abamectin > azadirachtin. The findings showed similarity with the results of Preetha *et al.* (2017) who reported that imidacloprid had the highest toxicity effect on thrips, followed by thiamethoxam. Leaf infestation rate at both 2 and 7 days after first spray did not show significant differences ($F_{4,10} = 0.6$, $p = 0.01$ and $F_{4,10} = 1.4$, $p = 0.01$, respectively) among the treatments (Table 5). Infestation at 2 days after first spray ranged from 48.9 ± 2.2 to 53.3 ± 11.5% but at 7 days ranged from 42.2 ± 2.2 to 48.9 ± 14.6%. Leaf infestation at 2 days after second spray of the insecticides showed significant differences ($F_{4,10} = 4.3$, $p < 0.05$) ranged from 33.3 ± 3.8 to 37.8 ± 2.2%. The highest infestation (66.7 ± 13.9%) was observed in untreated control plot followed by plot treated with Neem oil (37.8 ± 2.2%). Confidor 70 WG (33.3 ± 3.8%) and Liquor 1.8 EC (35.6 ± 2.2%) treated plots showed the lowest infestation and statistically similar infestation rate at 7 days after second spray ranged from 22.2 ± 2.2 to 31.1 ± 4.4% and showed significant differences ($F_{4,10} = 11.7$, $p < 0.01$). The highest infestation rate (64.4 ± 8.0%) was observed in untreated control plot followed by Neem oil (31.1 ± 4.4%). But the lowest leaf infestation (22.2 ± 2.2%) was observed in Confidor 70 WG treated plot. Infestation at 2 days after third spray showed significant differences ($F_{4,10} = 28.9$, $p < 0.01$) which ranged from 11.1±4.4 to

17.8±5.9%. The highest infestation (64.4±4.4%) was observed in untreated control plot while all other treatments showed statistically similar level of infestation. At 7 days after third spray of the tested insecticides showed significant differences ($F_{4,10}$ = 36.6, $p < 0.01$) which ranged from 6.7 ± 3.8 to 13.3 ± 3.8%. The highest infestation (60.0 ± 3.8%) was observed in the untreated control plot but all the treatments showed statistically comparable results.

Table 2. Toxicity effect of different insecticides against rose thrips at 2 HATs

Insecticides	Slope (± S.E)	LC_{50} (95% fl)	TR_{50}	LC_{95} (95% fl)	TR_{95}	χ^2 (df)	P
Confidor 70 WG	2.0 ± 0.2	214.3 (177.5-280.8)	16.2	1412.0 (845.6-3224.4)	6.9	7.8(3)	< 0.05
Actara 25 WG	2.2 ± 0.3	277.6 (233.6-362.0)	12.5	1548.6 (934.9-3688.5)	6.3	6.7(3)	= 0.082
Liquor 1.8 EC	2.6 ± 0.3	2080.7 (1788.7-2570.4)	1.7	9129.6 (6157.5-17000.1)	1.1	2.5(3)	= 0.480
Neem oil	3.7 ± 0.5	3462.3 (2652.0-11471.0)	-	9807.6 (5130.5-383573.7)	-	8.2(3)	<0.05

Each datum represents the mean of three replicates, each set up with 20 thrips. Concentrations are expressed as ppm. fl stands for fiducial limits.

Table 3. Toxicity effect of different insecticides against rose thrips at 4 HATs

Insecticides	Slope (± S.E)	LC_{50} (95% fl)	TR_{50}	LC_{95} (95% fl)	TR_{95}	χ^2 (df)	P
Confidor 70 WG	2.0 ± 0.2	168.1 (113.9-420.5)	20.2	1157.1 (447.3-39714.6)	7.3	8.0(3)	< 0.05
Actara 25 WG	2.5 ± 0.3	250.2 (217.0-307.1)	13.6	1158.4 (766.8-2278.2)	7.3	4.7(3)	= 0.195
Liquor 1.8 EC	2.8 ± 0.3	1861.0 (1278.1-6668.4)	1.8	7048.4 (3215.1-753506.8)	1.2	13.0(3)	< 0.01
Neem oil	4.2 ± 0.5	3403.9 (2618.0-15848.8)	-	8437.6 (4603.8-890583.1)	-	10.6(3)	< 0.05

Each datum represents the mean of three replicates, each set up with 20 thrips. Concentrations are expressed as ppm. fl stands for fiducial limits.

Table 4. Toxicity effect of the different insecticides against rose thrips at 6 HATs

Insecticides	Slope (± S.E)	LC_{50} (95% fl)	TR_{50}	LC_{95} (95% fl)	TR_{95}	χ^2 (df)	P
Confidor 70 WG	2.4 ± 0.2	147.6 (92.6-504.8)	20.4	708.3 (294.9-136954.9)	8.7	16.2(3)	< 0.01
Actara 25 WG	2.9 ± 0.3	227.6 (170.6-486.6)	13.2	856.5 (430.1-15405.6)	7.2	8.9(3)	< 0.05
Liquor 1.8 EC	3. 1± 0.3	1741.5 (1221.5-4729.1)	1.7	5973.3 (2963.6-260395.3)	1.0	13.4(3)	< 0.01
Neem oil	5.3 ± 0.6	3010.4 (2794.5-3337.2)	-	6136.9 (5082.3-8236.0)	-	7.6(3)	< 0.05

Each datum represents the mean of three replicates, each set up with 20 thrips. Concentrations are expressed as ppm. fl stands for fiducial limits.

Table 5. Effect of different insecticides on thrips infestation rate on rose leaf

Insecticide treatments	Infestation (%) of leaf					
	First spray		Second spray		Third spray	
	2 DAS	7 DAS	2 DAS	7 DAS	2 DAS	7 DAS
Confidor 70 WG	48.9 ± 2.2a	42.2 ± 2.2a	33.3 ± 3.8b	22.2 ± 2.2b	11.1 ± 4.4b	6.7 ± 3.8b
Actara 25 WG	57.8 ± 2.2a	46.7 ± 3.8a	37.8 ± 2.2ab	28.9 ± 4.4b	17.8 ± 2.2b	11.1 ± 4.4b
Liquor 1.8 EC	51.1 ± 5.9a	44.4 ± 2.2a	35.6 ± 2.2b	26.7 ± 3.8b	15.6 ± 2.2b	8.9 ± 2.2b
Neem oil	53.3 ± 11.5a	48.9 ± 14.6a	37.8 ± 2.2ab	31.1 ± 4.4b	17.8 ± 5.9b	13.3 ± 3.8b
Control	62.2 ± 8.9a	66.7 ± 10.2a	66.7 ± 13.9a	64.4 ± 8.0a	64.4 ± 4.4a	60.0 ± 3.8a

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey's posthoc statistic at P ≤ 0.05 (DAS = Days after spray)

Flower infestation rate at 2 days after first spray showed significant differences ($F_{4,10} = 7.5$, $p < 0.01$) among the treatments and ranged from 58.3 ± 4.4 to 63.5 ± 2.4% (Table 6). The highest infestation rate (78.3 ± 1.7%) was observed in untreated control plot while other treatments showed statistically almost similar. At 7 days after first spray of the insecticides resulted significant differences ($F_{4,10} = 8.6$, $p < 0.01$) and ranged from 52.2 ± 4.0 to 55.2 ± 1.6% (Table 6). The highest infestation (80.3±2.7%) was observed in untreated control plot while Confidor 70 WG (52.2 ± 4.0%) showed the lowest but statistically similar with those of other treatments. Flower infestation rate showed significant differences ($F_{4,10} = 5.4$, $p < 0.05$) at 2 days after second spray which ranged from 42.9 ± 9.6 to 47.1 ± 2.6%. The highest infestation (81.5 ± 3.3%) was observed in untreated control plot but Confidor 70 WG showed the lowest (42.9 ± 9.6%) which was statistically comparable with those of the rest treatments. At 7 days after second spray infestation ranged from 30.3 ± 8.8 to 38.9 ± 10.8% and showed statistically different (Table 6, $F_{4,10} = 3.9$, $p < 0.05$). Among the treatments the highest infestation (81.8 ± 3.0%) was observed in untreated control plot. On the contrary, the lowest flower infestation (30.3 ± 8.8%) was observed in Confidor 70 WG treated plot.

Table 6. Effect of different insecticides against thrips infestation rate on rose flower

Insecticide treatments	Infestation (%) of flower					
	First spray		Second spray		Third spray	
	2 DAS	7 DAS	2 DAS	7 DAS	2 DAS	7 DAS
Confidor 70 WG	58.3 ± 4.4b	52.2 ± 4.0b	42.9 ± 9.6b	30.3 ± 8.8b	19.0 ± 2.2c	9.7 ± 0.5c
Actara 25 WG	61.3 ± 2.8b	53.0 ± 6.5b	45.3 ± 7.8b	37.3 ± 14.3ab	25.2 ± 1.2bc	14.1 ± 1.0bc
Liquor 1.8 EC	62.2 ± 2.2b	54.6 ± 3.9b	43.2 ± 9.3b	32.2 ± 13.5ab	24.4 ± 1.2bc	11.9 ± 0.5c
Neem oil	63.5 ± 2.4b	55.2 ± 1.6b	47.1 ± 2.6b	38.9 ± 10.8ab	29.3 ± 2.2b	18.2 ± 1.1b
Control	78.3 ± 1.7a	80.3 ± 2.7a	81.5 ± 3.3a	81.8 ± 3.0a	80.9 ± 2.7a	79.9 ± 2.1a

Data expressed as mean± S.E. Means within a column followed by no common letter(s) are significantly different by Tukey's posthoc statistic at $P \leq 0.05$ (DAS = Days after spray)

Flower infestation at 2 days after third spray ranged from 19.0 ± 2.2 to 29.3 ± 2.2% and the results showed significant differences ($F_{4,10} = 163.3$, $p < 0.001$) among the treatments. The highest infestation (80.9 ± 2.7%) was observed in untreated control while the lowest (19.0 ± 2.2%) in Confidor 70 WG treated plot. Infestation rate at 7 days after third spray ranged from 9.7 ± 0.5 to 18.2 ± 1.2% and revealed significant differences ($F_{4,10} = 628.2$, $p < 0.001$). The highest infestation (79.9 ± 2.0%) was observed in untreated control plot but Confidor 70 WG proved the lowest (9.7 ± 0.5%) infestation.

Toxicity effect of chemical insecticides and neem oil on sucking and other insects, and their management on various crop plants have been reported by many authors (Amin *et al.* 2023, Mondal *et al*. 2023, Rahman *et al*. 2023, Ahmed *et al.* 2022). The active ingredients of insecticides and neem oil penetrate into the insect body through cuticle and with ingested food and consequently cause death of the insect. Eventually, the applied insecticides reduce insect population and infestation rate in the crop field. In this study, insecticides having contact and systemic mode of action were found while applied on thrips, and thrips infested rose plants. The findings revealed that the tested insecticides had significant toxicity effect on thrips and reduced infestation level of the thrips. Seal (2011) reported that various insecticides of the neonicotinoid group provided 42% to 75% control of *Thrips palmi*. Pradeep and Korat (2018) also reported that imidacloprid showed the reduction of maximum thrips population during the first, second, and third spray (61.48, 60.29, and 73.45%, respectively). The current findings showed that the Confidor 70 WG resulted the highest toxicity which caused the higher mortality of rose thrips.

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