

Efficacy of insecticides Closer and Sivanto in controlling the wax scale *Ceroplastes rusci* on figs

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Abstract

The study aimed to evaluate the efficacy of insecticides Closer and Sivanto and their combination on the fig wax scale *Ceroplastes rusci* (Linnaeus) (Homoptera: Coccidae), and to evaluate the safety period in fig fruits post application. The experiment was conducted on 1/6/2023 in Najaf Governorate/Haidariya District, in an private fig orchard using figs trees of 10 years or more. The treatments were spraying the insecticide Closer (sulfoxaflor) at a rate of 50 ml 100L⁻¹ water, and the pesticide Sivanto (Flupyradifurone) at 60 ml 100L⁻¹ water, and the combination of both pesticides at half (50%) dose. The efficiency of the two pesticides was evaluated based on the mortality rate of the wax scale insect on fig leaves and branches after 3, 5, 7 days post treatment. The results showed that Closer was more effective than Sivanto in reducing insect population densities, regardless of the insect stage, and led to mortality rates that ranged from 33 to 88%, compared to the significantly lower mortality rates in most cases resulted from Sivanto and even compared to that resulted where using the combination of the two pesticides at half dose. The pesticides residues in fruit samples were estimated using GC-MS analysis in three fruits per tree (replicate), starting from the first day after treatment to day 9 post application. The results showed that Closer decreased from the highest concentration (8.5 PPM) on the first day to 2.7 ppm at day 7, then to 1.3 ppm at day 8, and was undetectable after 9 days. Sivanto residues decreased in almost the same way and was 2.7 ppm at day 7 to 0.6 ppm at day 8 and was completely faded after at day 9.

Keywords: insect pests, food safety, Flupyradifurone, sulfoxaflor

Introduction

Fig *Ficus carica* trees are important fruit plants in Iraq and worldwide. Beside their delicious and tasty fruit, they contain unique nutrients and have therapeutic medical uses [3]. Fig fruits are of great importance in food because they contain many active compounds namely butylbutyrate, 5-hydroxymethylfurfural, malic acid, tetradecanoic acid, etc. [15]. Production of figs seems to be stable in most the fig-growing regions, especially in the biggest producer countries according to the 2020 Food and Agriculture Organization report [11]. The

global total cultivated area was estimated to be 289,818 hectares, with a production up to 1,315,588 tons annually. Turkey is considered the largest country in the production of figs with a total production of 2019 reached 310 thousand tons, followed by Egypt, Morocco, Algeria and Spain [11]. In Iraq, figs are grown in several areas, the most prominent of which are Salahdin, Naynaveh, Wasit and Babil Governorates, where the total production exceeded 9,000 tons in 2020 [12]. In Babil, the largest production is concentrated in Al-Kifl

district, south of the governorate, with an area of figs of more than 2,000 dunums [5]. In general, tree production in this region is slightly lower than average, while other governorates recorded tree production increasing by 20-30% above average [12]. Fig trees are infected with various agricultural pests, especially insects, the most important of which is the fig wax-scale insect, *Ceroplastis rusci* L. [20], which is recently found in Iraq. *Ceroplastis rusci* L is one of the pests of great economic importance due to the nature of its feeding behavior and the damage it causes to various fruiting and vegetative tree plant parts [14.]

This pest has great economic damage, as the infestation reduces the quantity and quality of fruits and leads to small size fruit and deformation which reduces their quality [7]. Severely infected trees show fall of the affected fruits, leaf wilting, and sometimes death of the branches [6]. It has also been found that insect's secretion of honeydew on plant parts leads to fruit and leaf contamination and dirtiness, accumulation of dust on the surfaces of the leaves, which affects photosynthesis process, encouraging other insect pests attack and growth of opportunistic fungi [20]. The successful control method is mainly depends on the appropriate timing and location [6], in addition to choosing the appropriate insecticide [2] and following the recommended concentration does that would not cause harm to the environment [8]. In general, it was found that there are some pesticides that are highly effective in controlling the wax-fig insects, the most important of which are Closer (Sulfoxaflor) and Sivanto (Flupyradifurone). This study aimed to evaluate the effective of

the two insecticides Closer (Sulfoxaflor) and Sivanto (Flupyradifurone) and their combined treatment on the wax-scale insect population, and to determine the pesticide residues in the fruit according to the safety period approved by the manufacturer company.

Materials and methods

This study was conducted on 15/3/2023 until 15/1/2024, where a fig private orchard of 5 acres planted with fig trees of same age was selected. A 12 fig trees were randomly selected from the orchard, taking into account that the trees should be similar in size and vegetative density of the tree, as well as their similarity by age. The samples were selected from three levels of the tree (upper, middle and lower) and from the four directions. Three leaves or branches were taken from each level and a total of nine sample each from each direction, then the samples were brought to the laboratory for observation. Number of wax-scale insects was calculated before the treatment using a 10x magnifying glass and all their data were recorded.

The control treatments started on 1/ 6/ 2023 using 3 trees (replications) for each treatment. Treatments were spraying the insecticides Closer (sulfoxaflor) at the recommended dose of 50 ml 100 L-1 water, or Sivanto (Flupyradifurone) at the recommended dose of 60 ml 100 L-1 water, as well as the combination of both pesticides with half dose each, while the control trees were sprayed with water only. The spray was performed using holder sprayer with a capacity of 100 L water. The numbers of dead insects (mortality) for all life stages were calculated after a period of 3, 5 and 7 days post treatment. The efficiency of the pesticide was calculated for each replicate according to Henderson

equation: $\text{Relative efficiency} = (1 - (a/b) \times (c/d)) \times 100$

Where :

- a) Density after application
- b) Density before application
- c) Density in control treatment before application
- d) Density in the control treatment after application

For estimating insecticides residues to confirm the safety period, three random fruit samples were taken daily from each tree for nine days post treatment. The samples were placed in black plastic bags and stored directly in the refrigerator at 8°C, where the pesticide residues in the fruits were estimated using a GC-MS device in the laboratories of the Ministry of Science and Technology [2]. The sample collection process was carried out according to a timetable that was set and in coordination with the Food Contamination Research Center/ Ministry of Science and Technology [2].

Results and discussion

The pesticide Closer showed insecticidal efficiency on the wax-scale insect on the leaves, which increased with increasing time after treatment. In general, Closer recorded

mortality rates that ranged from 28% three days after treatment to 81% after 7 days of treatment. This was slightly different from Sivanto, which led to insect mortality of 23.06% and 40.37% after 3 and 5 days post treatment with a significant difference from Closer, which recorded 54.95% mortality after 5 days of treatment. In general, the interaction treatment with half dose of both insecticides resulted in mortality rates significantly lower than that recorded by using either insecticides alone during the same period.

In the same context, with regard to the efficiency of pesticides on the scale insect on branches, the highest killing rates for the insect on branches were recorded in the Closer treatment, with mortality rates of 27.22, 47.29, and 79.42% after 3, 5, and 7 days post treatment, respectively. Although, the pesticides Closer and Sivanto did not differ after 3 and 5 days post treatments, Sivanto recorded 66.87% mortality at day 7 which was significantly lower than those recorded in Closer. Similarly, either pesticide recorded insects mortality significantly higher than that resulted from the combined treatment with half dose of both insecticides (Figure 2 .)

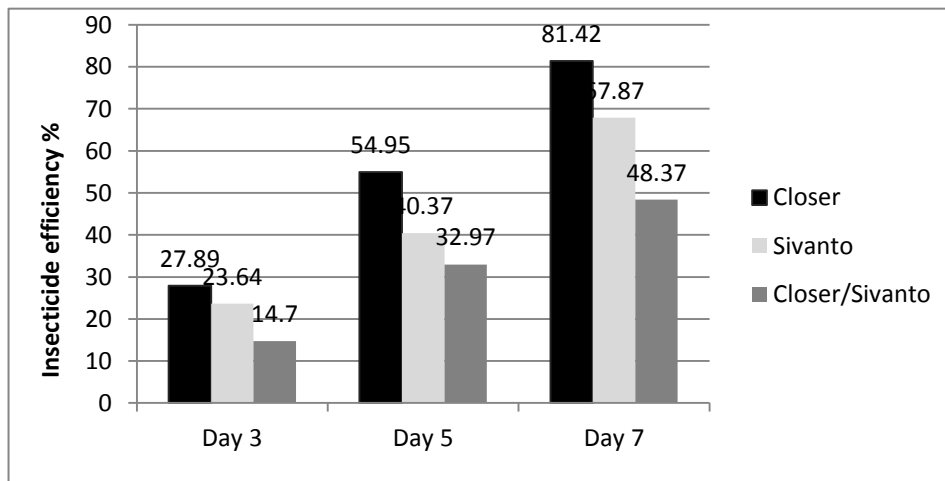


Figure1. Efficiency of the pesticides Closer and Sivanto and their interaction calculated by corrected mortality rate (%) on the wax-scale insect *C. rusci* on fig leaves at three periods post treatment. Values are means of 3 replications, means are compared among treatments based on the Least Significant Difference LSD ($P \leq 0.05$)

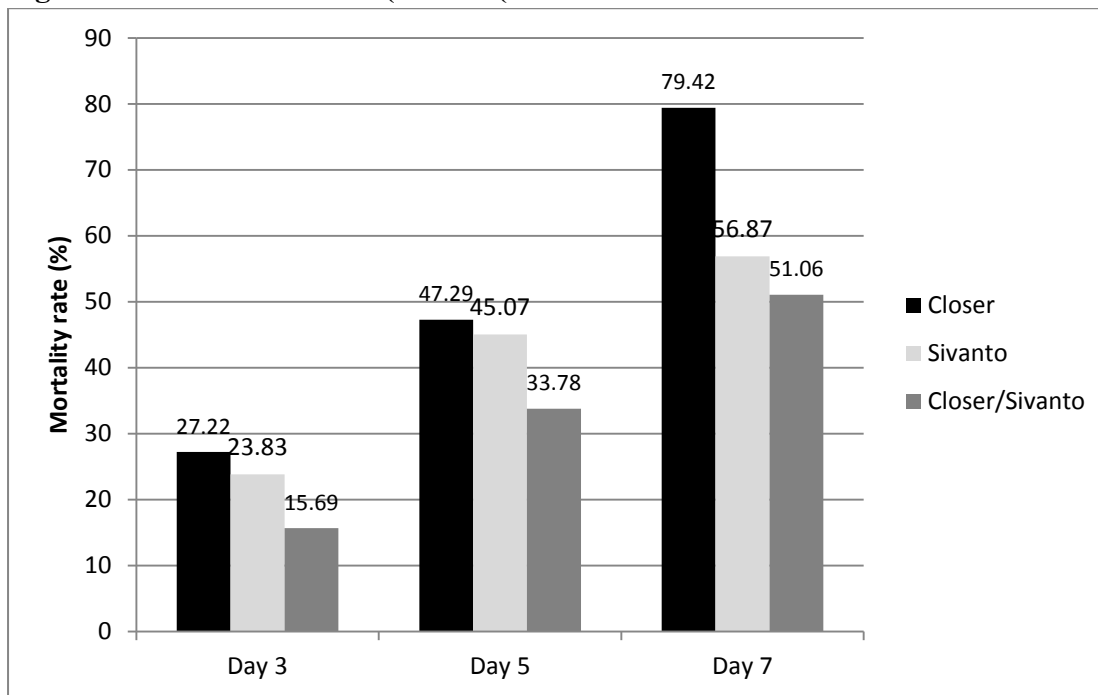


Figure2. Efficiency of the pesticides Closer and Sivanto and their interaction calculated by corrected mortality rate (%) on the wax-scale insect *C. rusci* on fig branches at three periods post treatment. Values are means of 3 replications, means are compared among treatments based on the Least Significant Difference LSD ($P \leq 0.05$).

The results of the GC-MS analysis of the pesticide Closer residues in fig fruits showed that Closer was at the highest concentration in the fruits 8.5ppm in day one post treatment, which decreased to 3 ppm on the sixth day with no difference from the fifth day (3.2ppm), while Closer concentration was 2.7 ppm after seven days, 1.3ppm on day eighth, while it was below the estimated level after 9 days (Figure 3). On the other hand, the

Sivanto pesticide decreased in the same manner after application (Figure 4) almost similar to the cases recorded with the Closer. However, Sivanto was decreased from 8- to 3.20 ppm on the day 4, while showed an equal decrease to Closer on the fifth and sixth days, to 2.7ppm and 0.6ppm on days 7 and 8 respectively, and couldn't be detected in day 9 post treatment (Figure 4.)

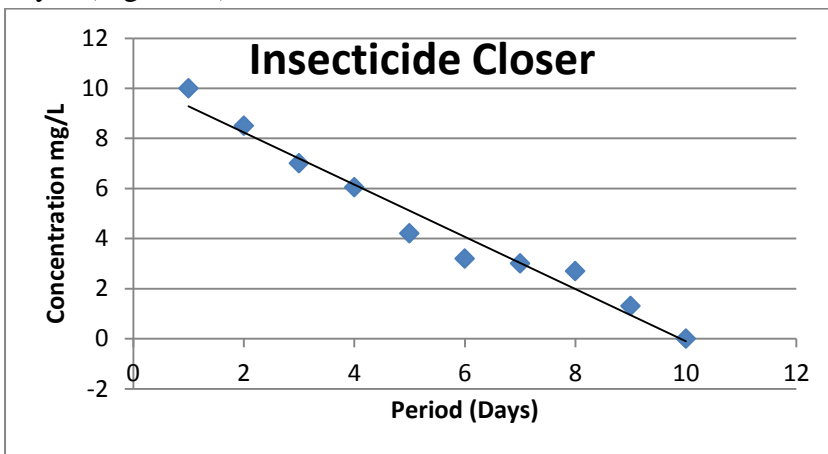


Figure3. Insecticide Closer diminish over time in fig fruits

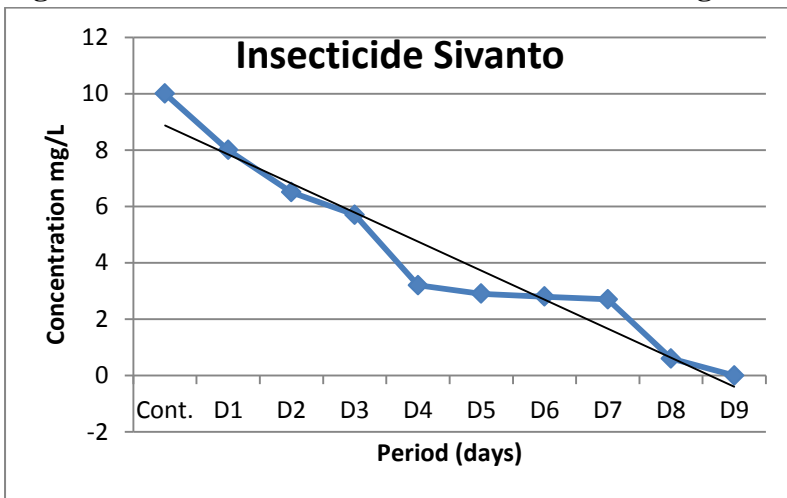


Figure4. Insecticide Sivanto diminish over time in fig fruits

As for the estimation of pesticide residues in the interaction treatment, the results recorded a decrease for each pesticide in approximately the same manner as in the case of the pesticide alone. But at concentrations of half the dose, which recorded a relatively higher scale. In general, Sivanto faded more quickly than the pesticide Closer, and recorded a clear decline

after the third day to the sixth day, compared to a gradual decline for the same period in the case of the pesticide Closer. In general, on the seventh day, the pesticide recorded almost equal levels of the two pesticides, while Sivanto recorded (0.097) ppm on the eighth day, compared to a higher concentration (0.49) ppm in the pesticide Closer (Figure 5.)

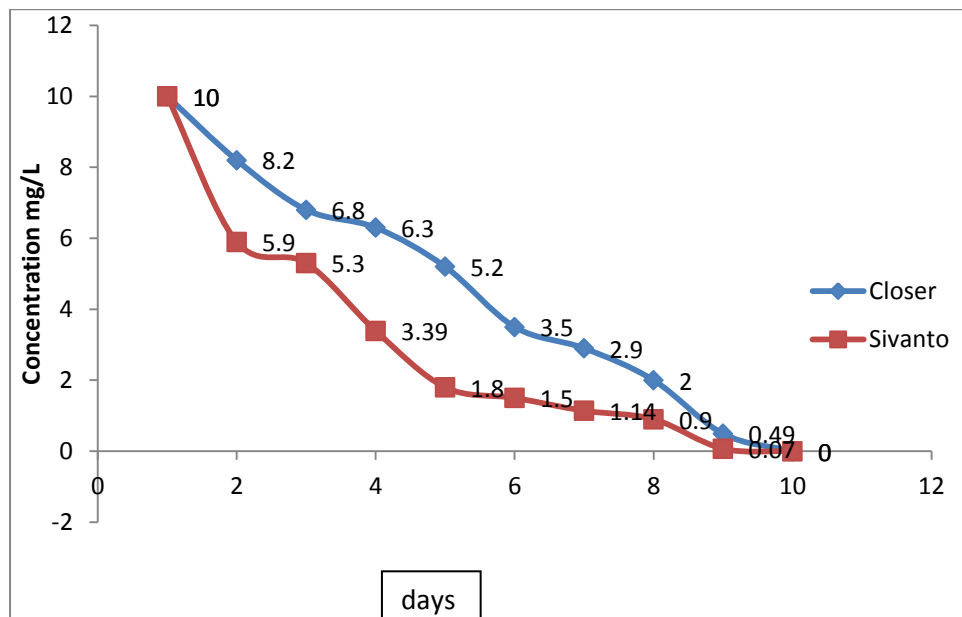


Figure5. Insecticides interaction treatment (Closer and Sivanto) and their diminish over time in fig fruits

In general when natural and nonchemical control methods failed in reducing the damage of insect pests, this leads to the pest outbreak and exceeding the economic limit or the insect density, enforcing the farmer to use chemical pesticides [18]. pesticides in controlling the wax scale insect is due to the presence of the thick waxy membrane that the insect uses as a protective shield that prevents pesticides from reaching the adult insects and nymph stages of the scale insect. Systemic insecticides can make the plant toxic to insects that feed on plant tissue. Many insecticides, especially those that are effective in working inside

plants systemically, have been registered and approved in a number of developed countries, especially in the United States. Systemic insecticides have an uncanny ability to travel through the plant's body, including those that are applied on the ground to the roots or that are vegetative and sprayed on the plant superficially [4]. The use of systemic insecticides gives the plant protection against burrowing and sucking insects for a relatively long period after application [1]. The effectiveness of the pesticide in reducing the wax-scale insect infestation was consistent with previous studies that indicated

effectiveness in controlling cotton insects in Ethiopia [3]. High results were recorded against the white mango insect with the pesticide compared to other pesticides [10, 12]. Studies also indicate that sulfoxaflor is somewhat less toxic than the recently banned neonicotinoids imidacloprid, thiamethoxam, and clothianidin, but much more toxic than other neonicotinoids (acetamiprid and thiacloprid) that are still in use in the EU [9]. Sivanto with its active compound Flupyradifurone is a butenolide insecticide that activates insect nAChRs. Flupyradifurone is a butenolide insecticide that is environmentally friendly to honey bees. The estimated national daily dose of flupyradifurone is 0.00094 mg/kg. It is highly toxic to aquatic animals, and considered a non-carcinogenic pesticide to humans. Moreover, it remains in the soil for a period of time and can be used as a stimulant and useful agent for soil enhancement.

In general, most fig producers resort to chemical control to reduce pest densities and maintain a certain level of production [17, 13]. However, despite the efficiency of pesticides in controlling the insect, the problem of pesticide residues remains, especially if the pesticide application recommendations are not adhered to the permissible limits [18]. In general, it was found that there are some pesticides that are highly effective in controlling scale insects, the most important of which are Closer (Sulfoxaflor) and Sivanto (Flupyradifurone). They were found to require a safety period of seven days on fruit trees, according to the instructions of the producing company .

Conclusion

The study confirmed the effectiveness of the pesticides Closer and Sivanto on the wax scale insect *Ceroplastes rusci* on figs where used at the recommended doses. Using a combination of the two pesticides at half dose was less effective on the insects than using either pesticide as a single treatment. Overall, Closer showed a higher insecticidal efficiency than that recorded with Sivanto. The pesticide is supposed to disappear after 7 days of treatment, but in this study, either pesticide was at the detectable level in the fruits even after 8 days of treatment.

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