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First report of population dynamics of oleander Aphid, Aphis nerii (Hemiptera: Aphididae) on three different species of oleander shrubs in Iraq

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Abstract The results revealed that *Aphis nerii* were presented on oleander plants from the end of December until the beginning of the June. The insects appeared on the bottom portion of the plants which has red, white, and pink colors, during December, and they reached their peak in February. The activity period of the insect was affected by environmental conditions, especially temperature and relative humidity (RH). At the beginning of March, insects began to move to the middle portion of the plants to for feeding the fresh leaf either on the lower or upper surface. They in the middle portion of the plant reached to peak in April. Insects moved to the top of the plant with increasing temperature at the end of March., The number of insects' increased quickly and reached its peak in May. Under laboratory conditions, Alpha cypermethrin at dosage state the was more effective, than Thiamethoxam and Abamectin. Alpha cypermethrin was mostly effective at 0.001ppm concentration. Alpha cypermethrin was harm and caused maximum mortality, which reached (100%) at the concentration of 0.001ppm followed by Thiamethoxam and Abamectin. Also, the result showed that the least effective treatment was Abamectin with only 33.33% mortality at 0.025ppm concentration. In laboratory, the condition was found to be mortality percentage dose and the type of the insecticide dependent. Experiments showed in laboratory that Alpha cypermethrin was the most toxic, followed by Thiamethoxam and Abamectin with LC_{50} values 0.02, 0.03, and 0.04 mg/L, respectively. Finally, this study could contribute as a guideline for pest risk assessment to protect oleander shrubs against the heavy infestation of *Aphis nerii*.

Keywords: *Nerium oleander*, Population dynamics, *Aphis nerii*, Oleander shrubs

Introduction

There are around 5600 species of Aphidomorpha,which, have been described worldwide (Blackman and Eastop, 2020; Favret, 2020) including the oleander aphid, *Aphis nerii* Boyer de Fonscolombe, (Hemiptera: Aphididae). Oleander aphids live in a group. The nymph and adult insect feeds on the plant host by sucking the sap from plant tissues. They prefer fresh parts, which leads to the weakening of the host and leaf curling. The amount of damage depends on the number of aphids on the plant, where the insects suck when they presents in large numbers, it may lead to the death of

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the plant (Talhog, 1984). In addition, the insect secretes the honeydew that covers the vegetative branches when sucking the sap from plant tissues, the dust particles were collected, and black sooty molds grow, which inhibits photosynthetic activity, respiration, and transpiration process. Generally, the insect is able to transmit several plant virus weakening the plant and reduce its production (Raccah and Fereres, 2009; Brault *et al*., 2011). The insect ejects excessive carbohydrates on its need to form the honeydew. These insects can damage plants in two ways, and is directly damaged by sucking the phloem tissue, and indirectly by virus transmission and secretion of excess carbohydrates from plant sap (Bachmann *et al*., 2014). These excretions can cause the occurrence of fungus on leaves, which restrains photosynthetic activity, resulting to chlorosis and consequent loss of product (Bachmann *et al*., 2014; Kadam *et al*., 2014). In aphids saliva, there is the pectinase which degrades the middle layer between cells and the cellulose. This aphid is able of extracted compounds for the synthesis of protein and excess sugars to form drops called honeydew. This aphid is capable to attack many plant in different families such as Apocynaceae (Nerium and Vinca), Asclepiadaceae (Asclepias, Calotropi, and Gomphocarpus), Asteraceae, Convolvulaceae, Euphorbiaceae and Rutaceae (Blackman and Eastop, 1984 and 2000 ; Martel and Malcolm, 2004) *Aphis nerii* is commonly distributed species in warm temperate and tropical regions of the world (Blackman and Eastop, 1984). Although it is widely spread around Southwest Asia (Mateu-Andres *et al*., 2015), it is hard to prove the natural origin in the Mediterranean area. This aphid is able to transmit many viruses such as sugarcane mosaic potyvirus and papaya ring spot potyvirus (Rothschild *et al.,* 1970; Hall and Ehler, 1980; Groeters, 1989; 1993). *Nerium oleander* L. is an evergreen shrub distributed in all regions of Iraq as ornamental shrubs in gardens and parks .The importance of oleander is for traditional medicin being, used in activation of the heart, expectorant, diuretic, emetic, and diaphoretic (Patel *et al*., 2010). Each portion of the oleander plant contains toxic compounds, including oleandrine, oleandrigenin, and glycosidase (Bandara *et al*., 2010). The main cause for acute toxicity is contained different species of glycosidase such as oleandrine, neriine, cardenolides, strychinine (Barbosa *et al*., 2008; Hauptman *et al*., 1999). The glycosidase may increase the poison effect in these materials, which are mostly non-polar, and the other toxic components present in plants that have the ability to soluble in fats. Aphid is found in each part of the plant like the lower-upper leaves, branches and flowers. There is a lack of information about the dynamics of this aphid in Iraq. So that, the aim of this study was to examine the population dynamics of the oleander aphid *Aphis nerii* Fonscolombe (Hemiptera : Aphididae) in middle Iraq. This work would be helpful for the assessment of the incidence and

severity of damage caused by the aphids.

Material and methods

Study area

This study was conducted in Iraq, from December 2019 to June 2020 in the gardens located in Shirqat city. This city lies approximately between 35 ℃49 latitude and 43 ℃24 longitude, which means that it is located in the middle of Iraq. Temperature and humidity rates were obtained from an Agrometeorological station in Iraq.

Data collection

Nerium oleander L. is an evergreen shrub distributed in all regions of Iraq as ornamental shrubs in gardens and parks .The importance of oleander is for traditional medicin being, used in activation of the heart, expectorant, diuretic , emetic, and diaphoretic (Patel *et al*., 2010). Each portion of the oleander plant contains toxic compounds, including oleandrine, oleandrigenin, and glycosidase (Bandara *et al*., 2010). *Aphis nerii* population were estimated on the oleander plants, *Nerium oleander* Red, White, and Pink color. Cultivation of the plant was carried out according to normal practice and no pesticides were applied during the study period. Samples were taken equally from the bottom, middle, and top thirds of the plants and selected terminals were taken randomly within each portion of the plants. Samples were taken every 15 days, from three leaves infested with aphids and sampled transferred to the laboratory to count the number of nymph (Figure 1, 2).

Experimental insect

The field strain of *A. nerii* nymph was collected from unsprayed plants during the study period. The heavily infested leaves *Oleander nerium* plants with aphid were picked and transferred to the laboratory in paper bags and used for the bioassay experiments.

Tested insecticides

The common names of the selected insecticides, trade names, manufacturer and field recommended rates are listed in Table 1. The pesticides were selected from diverse groups which are being commonly used against sucking insect pests. These were purchased from the market.

Figure 1. *Aphis nerii* B. **Figure 2.** *Nerium oleander* L.

Bioassays

The efficacy of Alpha cypermethrin 5 EC, Thiamethoxam 25 WG, Abamectin 1.8 EC (Table 1) was evaluated against the *A. nerii* nymph under laboratory conditions using fresh leaves of *Oleander nerium* which were dipped in different insecticide solution for one minute. The leaves were treated with the solution that dried on a filter paper in open air. A slightly moistened filter-paper was placed in petri dishes to keep the leaf material turgid. For control treatment, leaf discs were immersed in water only. Ten apterous aphids of same size were released in each petri-dish on these leaflets using fine camel hair brush. Each concentration was replicated three times. Three replications were maintained for each treatment. Based on the mobility of the nymph body parts and alteration in the colour of the body, the mortality of nymphs was verified and the data was recorded at 24 hours after treatment. The Petri dishes were placed at 25 ± 3 ℃, RH 62 ± 5% and 14:10 (light: dark) photo- period.

Table 1. Tested insecticides against *A. nerii*

Treatments	Trade name	Chemical Class	Manufacturer	Dose
Alpha-cypermthrin	Fastac 10% EC	Pyrethroid	Shenzhen	40m/100L
Thiamethoxam	Actara 25% WG	Neonicotinoids	Syngenta	40g/100L
Abamectin	Medamec 1.8 EC	Avermectin	Vapco	50m/100L

Statistical analysis

Analysis was done by using aphid densities obtained during study data were examined using one way ANOVA followed by Duncan's post test to detect significant differences at a probability level of 5% ($p \leq 0.05$). The statistical analyses were carried out on SAS computer program. Figures were drawn using Microsoft Excel 2013.

Results

Aphid population dynamics at the bottom portion

In each portion, aphid populations increased along with time on all host plants, and oleander aphids, *A. nerii* were present on the upper and lower surfaces of the leaves, twigs, and flowers. The results showed that the population density of insects in the bottom portion of the plants fluctuated until beginning of June. Higher infestation on oleander plants Red, White, and Pink color was recorded in the 1st week of February with 207, 231 and 269 aphids/leaf, respectively with 10.04c ºtemperature and 76.52% relative humidity (Figure 3).

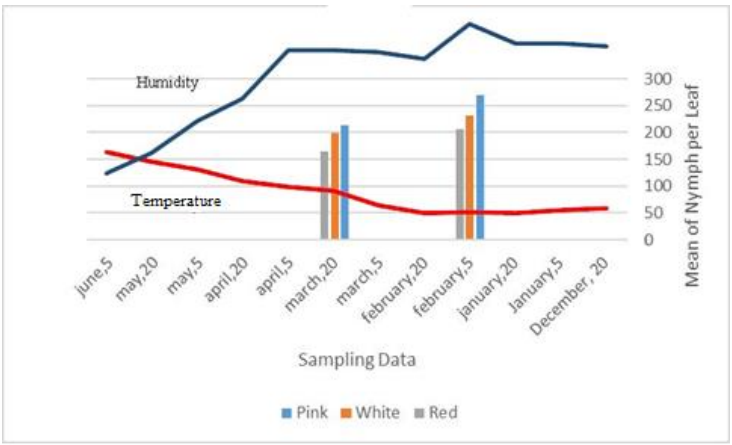

Figure 3. Population density of *Aphis nerii* at the bottom portion for oleander plant

The studied area was exposed to cold waves in the second week of February, this caused the death of some trees and shrubs and the population density of aphids recorded but the Population density again increased in the 3rd week of March. Population density on three oleander plants were reached 165, 199 and 214 aphids/leaf, respectively with temperature of (17.38 c ٩) and relative humidity of (67.19 %).

Aphid population dynamics at the middle portion

In the middle portion of plant, the insects was appeared in the 1st week of March on the three types of oleander plants. Population density began in small numbers of aphids and gradually increased to reach a maximum numbers with 254, 274 and 296 aphids/leaf, respectively. That was in the 1st week of April when temperature was (20.55 c ٩) and the relative humidity was (64.28 %) (Figure 4).

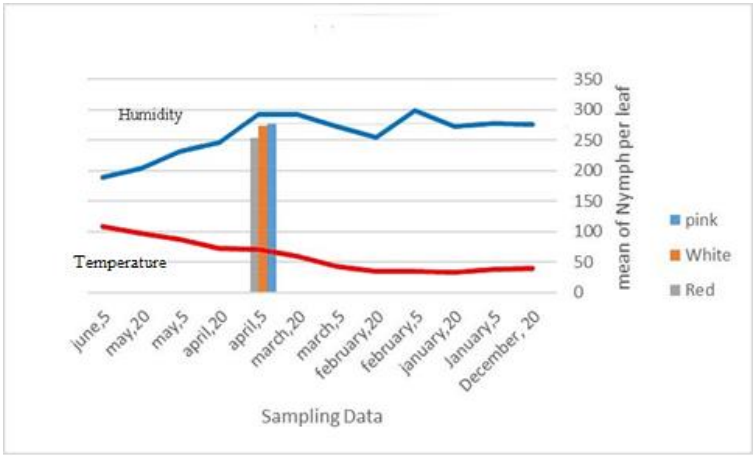

Figure 4. Population density of *Aphis nerii* at the middle portion of oleander plant

Aphid population dynamics at the top portion

The insect at the top portion of the plants had not appeared in beginning of the season, but the first appearance was in the 3rd week of March where population density reached to 98,107, and 127 aphids/leaf, respectively on three oleander plants with temperature (17.38 c ٩) and relative humidity was (67.19 %).Population density had quickly increased , and it reached to the peak in the 1st week of May with 278 , 311, and 372 aphids/leaf, respectively on three oleander plants with temperature (25.13 c ٩) and relative humidity was (42.16 %). After that, population density receded in the first week of June where it reached to 59,74, and 105 aphids/leaf, respectively on three oleander plants (Figure 5).

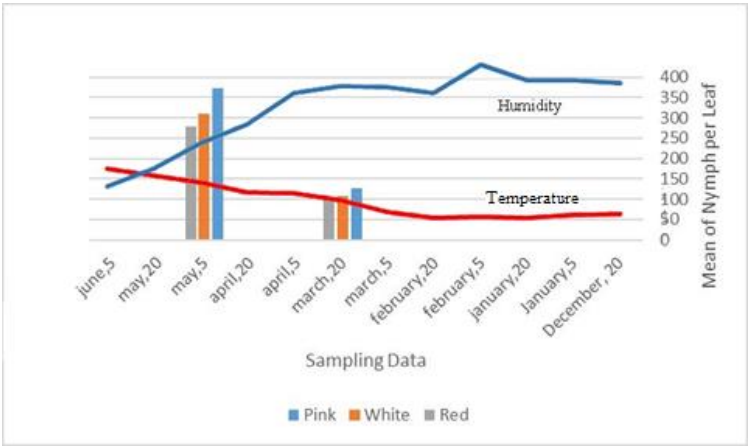

Figure 5. Population density of *Aphis nerii* at the top portion of oleander plant

Monthly population density

The results showed that the highest number of insects reached its peak in April with 1356 aphids/leaf on the Pink plant while the lowest number of insects was 54 aphids/leaf on Red plant in December (Figure 6).

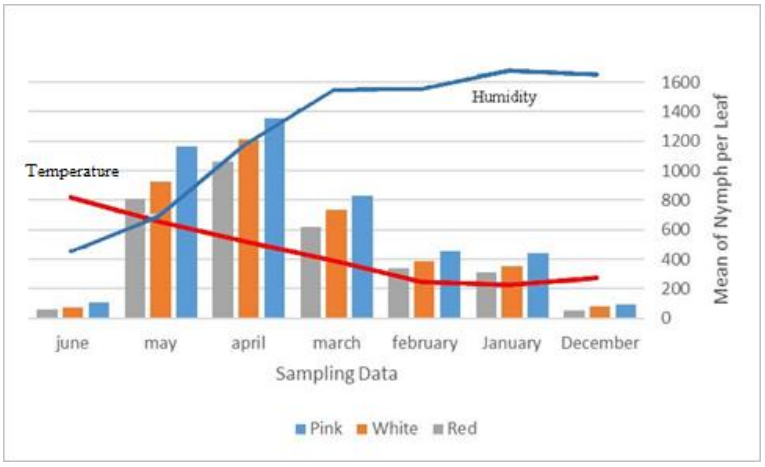

Figure 6. Monthly population density of *Aphis nerii* B. on oleander plant

Effect of insecticides on the nymphs aphid

The efficacy of Alpha- cypermthrin, Thiamethoxam and Abamectin against *A. nerii* nymphs using leaf-dip bioassay technique was investigated. Show that all the treatments showed significant differences with each other except treatment of the control (Figure 7). There was no mortality observed in control where no insecticide was applied. Results showed that, toxicity to Alpha cypermthrin (LC_{50} = 0.02 mg/L) was higher than Thiamethoxam (LC_{50} = 0.03 mg/L) and Abamectin (LC_{50} = 0.04 mg/L) as seen in Table 2.

The highest mortality (100%) was observed in Alpha cypermethrin application compared to the other insecticides. The abamectin treatment showed a less effective of 33.33% mortality of nymphs poplar trees after application. The performance of insecticides in descended order showing mortality was Alpha cypermthrin > Thiamethoxam > Abamectin at 0.001ppm concentration application in the laboratory bioassay. The insecticide concentrations and duration had significantly affected on the mortality of nymphs. The exposure time of insecticides increased the mortalities of nymphs also increased. All treatments appeared high mortality ratio with increased concentrations. Alpha cypermthrin was a highly selective insecticide for controlling a broad range of aphids and many other sucking insects as well as providing long-term control. This insecticide can be identified as rapidly suppress the feeding behavior of aphids, and thus its mode of action was different from that of Pyrethroids, which act as agonists on the insect nicotinic acetylcholine receptor (nAChR).

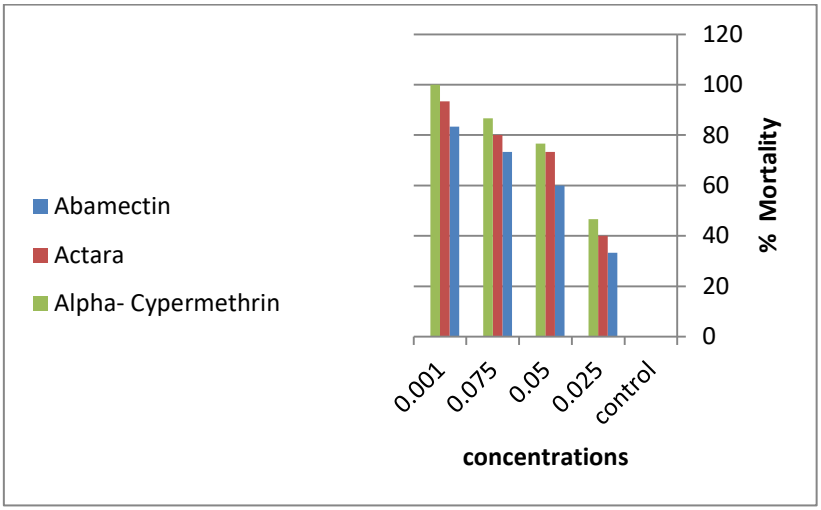

Figure 7. Toxicity of Alpha - Cypermethrin , Actara and Abamectin to *A. nerii* after exposure to different concentrations

Table 2. The lethal and sublethal concentrations of tested insecticides against the nymphs of A. *nerii* after 24 h of treatment by leaf-dip technique

Insecticide	LC50	Fiducial limit	Slope
Alpha cypermthrin	0.02	0.002-0.038	2.38
Thiamethoxam	0.03	0.014-0.046	1.59
Abamectin	0.04	0.011-0.049	1.47

Discussion

Aphids are the major pests of plant crops in temperate areas of the world. *Nerium oleander* is an important medicinal plant in folk medicine. The plant has provided a source of inspiration for novel drug compounds, as plants derived medicines have made significant contributions towards human health. In general, the population density of insects on the plants fluctuated. These results are in agreement with Brabec *et al*., 2014 who reported that aphid populations can show periodic fluctuations. The reason for the differences in the infestation of three types oleander aphids and in the population density is attributed to the variation in the components of plants sap in the species, Similar results with those reported by (Banks and Macculary, 1964; Müeller, 1966; Younis *et al*., 1985) The difference in the degree of the infestation and population density is due to mineral components in the varieties. The population dynamics of aphids can be disturbed by seasonal changes in climate conditions, physiological characteristics of the host-plant, agricultural methods, and administration practices (Sequeira and Dixon, 1997). Indeed, a good knowledge of the population dynamics of insects is important for crop protection (Kindlmann and Dixon, 2010). Population density of aphids can reach high abundances in warm-temperate and tropical regions (Gutierrez *et al*., 1974). Population density for fertility of *A. nerii* is depended on different species of milkweed and host plant species. A number of plant quality such as cardenolide concentration and trichome density were found to be the intrinsic (Agrawal, 2004). Some properties of crops may prevent or attract sucking insects, and local variation in resource quality profoundly effects the overall population dynamics (Kadam *et al*., 2014; Riolo *et al*., 2015). The plant with Pink flowers had more infestation among the three oleander plants while the plant with Red flowers were less infested among them. These results are compared to the work of Karawya *et al*. (1973) who reported that plant with Red flowers produce compounds such as cardiac glycosides more than White flowers, especially in the flowering stage. Population growth of *A. nerii* is affected by variation in many plants including defense chemistry, nutrient content, and leaf hairiness (Agrawal, 2004). Since aphids pose a significant challenge to food production (Bell *et al*., 2015). Prediction of aphid peaks in field is an important tool for ecological studies, and can be useful for protecting field crops (Malaquias *et al*., 2015) (Figure 4).

The results are recorder to be useful in understanding the population density *Aphis. nerii* and Prediction of the start of appearance of *A. nerri* on oleander plants. The insights may be helpful in decision making, implementation of controls measures, and determine the timing of population peak for these important oleander plants. Field experiments are needed to verify the present laboratory findings.

Effect of insecticides after 24h

From the study, it was evident that Alpha cypermthrin showed higher effectiveness in suppressing aphid nerium than the other insecticides. These results are in agreement with (Athanassiou *et al*., 2015) who reported that alpha-cypermethrin was more effective than thiamethoxam for the control of both adults and larvae of *Trogoderma granarium*. Synthetic Pyrethroids are neuropoisons that act on the axons in the peripheral and central nervous systems in nymphs, altering the axonic sodium channels and allowing excessive ion entrance, thereby causing abnormally nervous activate and eventually paralysis as described by (Stenersen, 2004).) Both of these insecticides are effective against sucking insects like jasside, whiteflies, aphids, and mealybugs. (Tomlin 2006 ; Rudramuni *el al*., 2011; Sontakke *et al*., 2013) Under laboratory conditions, LC_{50} values showed that Alpha cypermthrin exhibited the highest toxicity against *A. nerii* .There is no information on the impact of Pyrethroides (alpha – cypermethrin) on *A. nerii*. In our study, we showed that mortality increased with time. This was obvious showed after exposure to more diluted concentration for both insecticides. Similarly, (Sallam *et al*., 2009) showed that the mortality percentage of *Rhopalosiphum padi* L. and *Metopolophium dirhodum* W. increased with time after exposure at concentrations between 0.3 and 10 ppm. Also these outcomes agree with (Al. Jubouri, 2005) who found the mortality percentage of *Egeirotrioza justa* (Burck and Laute) increased with time after exposure at concentrations between 0.001 and 0.003 ppm.

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