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STUDY ON THE POPULATION DENSITY OF INSECT PESTS OF BROCCOLI, *BRASSICA OLERACEA*, IN THE JADIRIYAH AREA OF BAGHDAD, IRAQ

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ABSTRACT

A field study was conducted in the fields of the College of Agricultural Engineering Sciences at the University of Baghdad in Al-Jadriya during the 2018 agricultural season. The objective was to survey the population densities of pests affecting broccoli (*Brassica oleracea*). The results revealed that the broccoli plants in the open field were affected by various pests. On September 24, the highest density of two-spotted red mite (*Tetranychus urticae*) eggs reached 35 eggs per leaf. On November 12, the highest density of mite nymphs was recorded at 28 nymphs per leaf. The leaf miner, *Liriomyza sativae*, exhibited the highest density of 23 tunnels per leaf on September 17. Additionally, the highest density of whitefly nymphs (*Bemisia tabaci*) was observed on October 1 and November 17, reaching 29 nymphs per leaf. The results also indicated the presence of the aphid lion, *Chrysoperla carnea*, as a natural enemy. Furthermore, the parasitoid *Diglyphus isaea* was found on the leaf miner, while the parasitoid *Eretmocerus mundus* was identified on the whitefly. Therefore, understanding the species of pests and their density attacking agricultural crops is crucial. This knowledge allows for the release of natural enemies in the field to mitigate pest infestations.

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INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica*) is a winter vegetable belonging to the cruciferous family (Brassicaceae), and has been known for more than 2,700 years in the Mediterranean regions and regions of Asia Minor (Al-Issawi and Al-Mohammedi, 2023). It was known by the Romans since ancient times and was cultivated by the Italians. Broccoli is typically consumed while in the flower bud stage, with thick, juicy pods (Decoteau, 2000). The broccoli plant is characterized by its good nutritional value, being considered one of the low-sodium, fat-free, and low-calorie foods. It also contains various vitamins, including vitamin A and C, carotenoids, folic acid, niacin, and riboflavin. Additionally, it provides essential nutrients such as calcium, iron, phosphorous, and potassium (Beecher, 1994; Michaud et al., 2002). Broccoli is a rich source of glucosinolates, which have been shown to reduce the risk of cancer. It has been noted that consuming more than one meal per week can reduce the risk of cancer by 45% and also help prevent retinal diseases (Kirsh et al., 2007).

Broccoli has an annual global production around 20,842,200 tons, with the world's largest producers being China, producing about 9,030,990 tons annually. Egypt is the tenth largest in annual broccoli production (201,201 tons) (Orzolek, et. al., 2012).

Broccoli production depends on many factors, such as the suitability of the variety for the region. Although there are international varieties of this crop, research authorities and international companies have been developing modern varieties with better nutritional and productive qualities as a way to promote this crop globally. The characteristics of these varieties are influenced by genetic factors (Hassan et al., 2002). Broccoli crop is susceptible to various insect infestations, including the cabbage grey aphid (*Brevicoryne brassica* L.), cabbage white butterfly (*Pieris rapae*), great white butterfly (*P. brassicae*), diamondback moths (*Plutella xylostella*), cabbage cutworm (*Agrotis ipsilon*), and Grasshopper (*Melanoplus* sp.). These pests also contribute to economic damage (Karso et al., 2022).

Whitefly (*Bemisia tabaci*) nymphs suck the sap of the host plant from the lower surfaces of the leaves at all stages of their life cycle, including the adult stage. These insects cause severe damage when they live in large numbers. Their damage is worsened by the secretion of saliva within the plant body, which contains enzymes that facilitate the digestion of the food they absorb. This leads to the drying and death of the plant tissues. The insects also secrete honeydew, which attracts fungi that grow on it and stick to it. This causes yellowing and wrinkling of the leaves, shortens the life of plants, and reduces the production. Whiteflies start to appear on the lower surfaces of the leaves in the spring. They mate and lay eggs, which secrete a bale of eggs that penetrates the epidermis of the host plant into the mesophyll tissue. The eggs hatch into crawling nymphs that are active in movement and wander on the plant for a wax cap (Daniel et al., 2016).

Leaf miners are important pests that cause significant economic losses to most agricultural crops (Sadiq et al., 2020). Al-Jassani et al. (2016) reported the relative presence of the species *Liriomyza sativae* as well as other species on cucumbers, and it was recorded on nine plant families. However, they prefer to feed on the cucurbit, nightshade, and legume families (Spencer, 1973, 1990). Babi (2001) showed that leaf miners, belonging to the genus *Liriomyza*, originated on the South American continent, from which they spread to other countries of the world, causing damage to vegetable crops in open fields and greenhouses. Andersen et al. (2002) indicated that *L. sativa* is a very dangerous pest on cucumbers, beans, peas, tomatoes, melons, and pumpkins.

The males and females of the leaf miner are vectors for viral diseases during egg laying or feeding processes (CABI/EPPO, 2006). The leaf miner inserts its eggs under the leaf cuticle and, after hatching, the first larval stage emerges, which feeds on the tissue of the middle layer of the leaf between the upper and lower surface of the leaf. This leads to the formation of the winding tunnels that characterize this insect's egg laying and feeding on the site of the injury (AL-Mashhadani, 1998). The leaf-mining flies have 5-10 generations per year (Tawfik, 1993).

The two-spotted spider mite (*Tetranychus urticae*) is one of the most important economic pests that affects field crops, greenhouse crops, ornamental plants, and fruit trees (Gatarayiha, 2009; Puspitarini, et al., 2011). One of the most important factors that makes this mite a dangerous pest is the ability of females to produce offspring. The damage to plants is usually associated with a reduction in physiological processes (transpiration and photosynthesis), as well as a decrease in yield and quality (Ay et al., 2005; Gorman et al., 2002; Malais and Ravensberg, 2003; Van Leeuwen, 2010). This is due to the mite's short life cycle and the large number of generations during the growing season, in addition to its high fertility (Meyer and Craemer, 1999). Its presence on the lower surface of the plant leaves mainly leads to a decrease in the efficacy of pesticides due to the difficulty of delivering the pesticides to all affected parts of the plant, and not covering the plant completely (Helle and Sabelis, 1985).

Chemical pesticides have been used since ancient times and are considered one of the oldest methods used to control agricultural pests. Negative aspects of insecticide use include the development of secondary pest problems, the evolution of pesticide resistance, human health problems, contamination of groundwater, and often, increased crop production costs. While some insecticides are directly toxic only to specific insect pest populations, others can cause unexpected outbreaks of secondary pest populations that could potentially be controlled by beneficial insects (Naranjo and Luttrell, 2009). Biological control is an approach to pest control that may avoid the problems associated with the use of chemical control. Because the larvae of green lacewings (Neuroptera: Chrysopidae) are highly efficient predators of many important agricultural pests, green lacewings are often used in augmentative biological control programs. Because there are few studies on the broccoli crop in Iraq, this study was chosen to survey the population densities of insects and their natural enemies in the Jadiriyah area of Baghdad, Iraq.

MATERIALS AND METHODS

Experimental location and design

The experiment was conducted in the fields affiliated with the College of Agricultural Engineering Sciences at the University of Baghdad in Jadiriyah, Iraq, during the fall season of 2018. The primary aim was to survey and determine the population density of insects and their natural enemies.

The soil of the designated experimental field underwent thorough preparation, involving plowing, smoothing, and leveling to ensure uniformity. Subsequently, the land was divided into three replicates, with each replicate comprising 10 experimental units. Within a single replicate, three lines were established, maintaining a distance of 0.75 meters between each line. To prevent any potential confusion between transactions, a space of 0.60 meters was maintained between the individual units within the same line, serving as an insulator.

Seedling cultivation

A cork plate obtained from a nursery was utilized for planting Mar Fi hybrid broccoli seeds, provided by Hortiseeds Company, on 9/28/2018. The experimental unit consisted of 14 plants, with 40 cm spacing between each plant. This scientific experiment followed a randomized complete block design (RCBD).

Sampling

Weekly samples of 45 leaves were systematically collected and transported to the laboratory for pest examination under a light microscope. This sampling procedure was consistently executed and recorded on a weekly basis until the conclusion of the season.

Application of NPK fertilizer

The NPK fertilizer was applied in accordance with the recommended quantity. This particular procedure was incorporated as part of the comparative transactions undertaken during the experiment.

Application of algae extract marine fertilizer

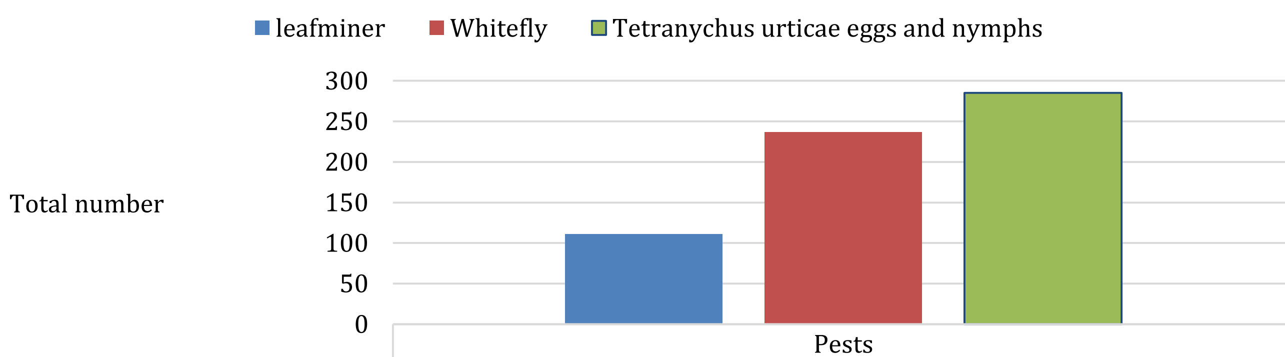
The algae extract marine fertilizer was administered through two sprays, with a 15-day interval between each application. This additional step in the cultivation process aimed to enhance the nutrient content and overall health of the broccoli plants.

Statistical analysis

Throughout these procedures, a one-way Analysis of Variance (ANOVA) was employed, and Tukey tests were subsequently utilized for statistically distinguishing individual means whenever significant differences were identified overall.

RESULTS AND DISCUSSION

Figure 1 illustrates the total numbers of pests on the broccoli crop, revealing significant differences (P=0.027). Notably, the eggs and nymphs of the two-spot dreaming mite showed superiority, while no significant differences were observed between the leaf miner, and whitefly nymphs.



	Pests
leafminer	111
Whitefly	237
Tetranychus urticae eggs and nymphs	285

Figure 1: The total number of pest populations on broccoli (*Brassica oleracea*).

Figure 2 shows the population densities of broccoli pests, including the leaf miner, *Liriomyza sativae.* The numbers of leaf miners started rising at the beginning of the season, as they were recorded at 19 tunnels/leaf and reached the highest number of 23 tunnels/leaf on September 17. Then they began to gradually decrease with the growth of the plant and increased slightly until they reached 12 tunnels/leaf on September 5. Then, they continued to decline until the lowest number of 2 tunnels/leaf was recorded on December 10, which was the end of the season. Two leaf miners were detected, including *Liriomyza bryoniae* on squash crop and *Phytomyza horticola* on tomato crop. They preferred median level leaves for their larvae throughout the growth season (Kathiar et al., 2018a). The highest average of infested leaves of eggplant (*Solanum melongena*) was 6.67 leaves and the highest average of tunnels by leaf miner was 9.87 tunnels. The highest percentage of infestation was also recorded (Kathiar et al., 2018b). The presence of the parasitoid (Eulophidae) *D. iseae* was recorded as a natural enemy to control the leaf miner. These results agree with the recording of the presence of the same parasitoid on the cucumber leaf miner (Falih, 2009, 2016).

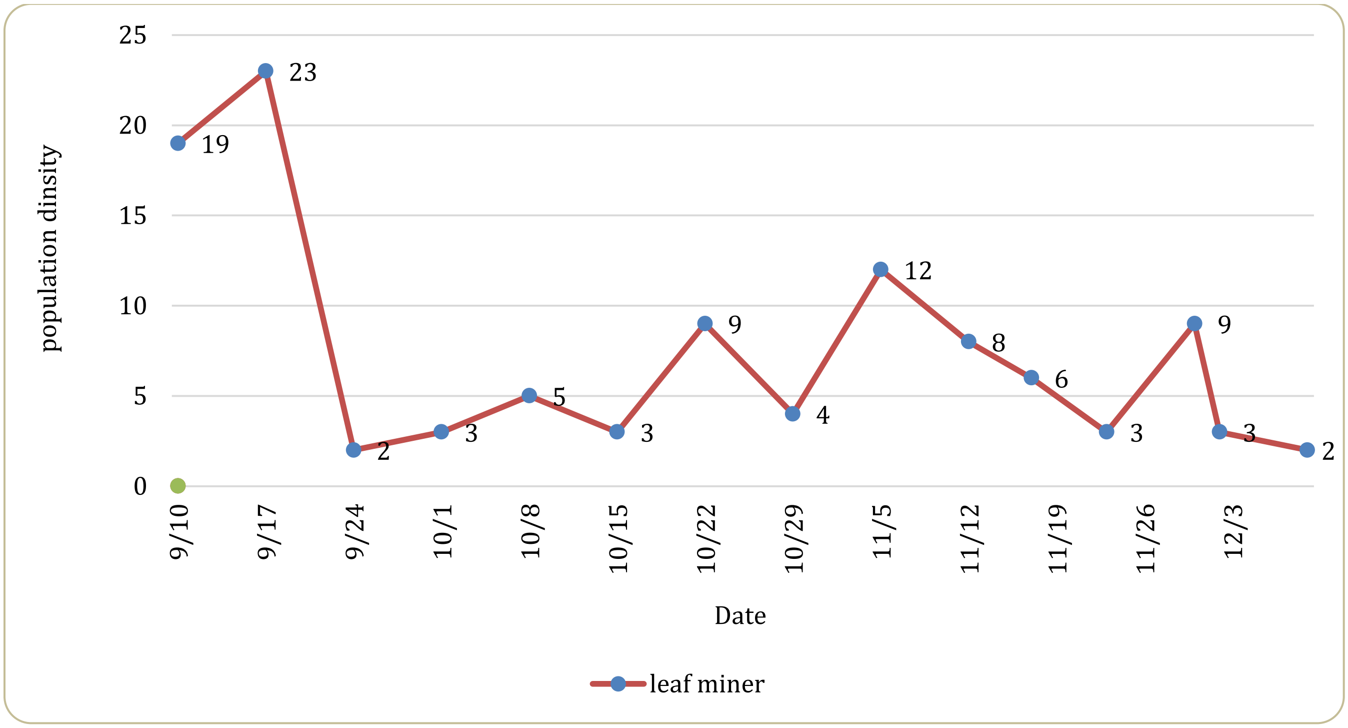


Figure 2: Leafminer population density on broccoli (*Brassica oleracea*).

Figure 3 shows the presence of the whitefly nymphs, with the highest density of nymphs recorded at 29 nymphs/leaf on October 1 and November 17. The densities of nymphs fluctuated between high and low throughout the research season. They started with a gradual rise of 17 nymphs/leaf on September 24 and increased to 29, 25, and 27 nymphs/leaf on October 1, 8, and 15, respectively. Subsequently, a decrease to 11 nymphs/leaf on October 22 was observed, followed by a gradual increase to 29 nymphs/leaf on November 17. They usually declined when the weather changed, reaching 3 nymphs/leaf on December 23. Changes in environmental conditions, often associated with weather alterations, impacted these fluctuations. The ability of insects to adapt to temperatures and resort to hibernation to preserve species explains the observed patterns, aligning with the findings of Falih (2017) where the highest density of whiteflies was 29.67 nymphs/leaf on sunflower.

Figure 4 presents the presence of eggs and nymphs of the two-spot dreaming mite. The highest density of eggs was recorded at 35 eggs/leaf on September 24, while nymphs reached their peak at 28 nymphs/leaf on November 12. The lowest counts were zero eggs and nymphs/leaf on September 10. A gradual increase in egg numbers occurred from 12 to 20 eggs/leaf, reaching 28 eggs/leaf on October 22, November 5, and November 17, respectively. Subsequently, numbers gradually decreased, reaching 3 eggs/leaf on December 23.

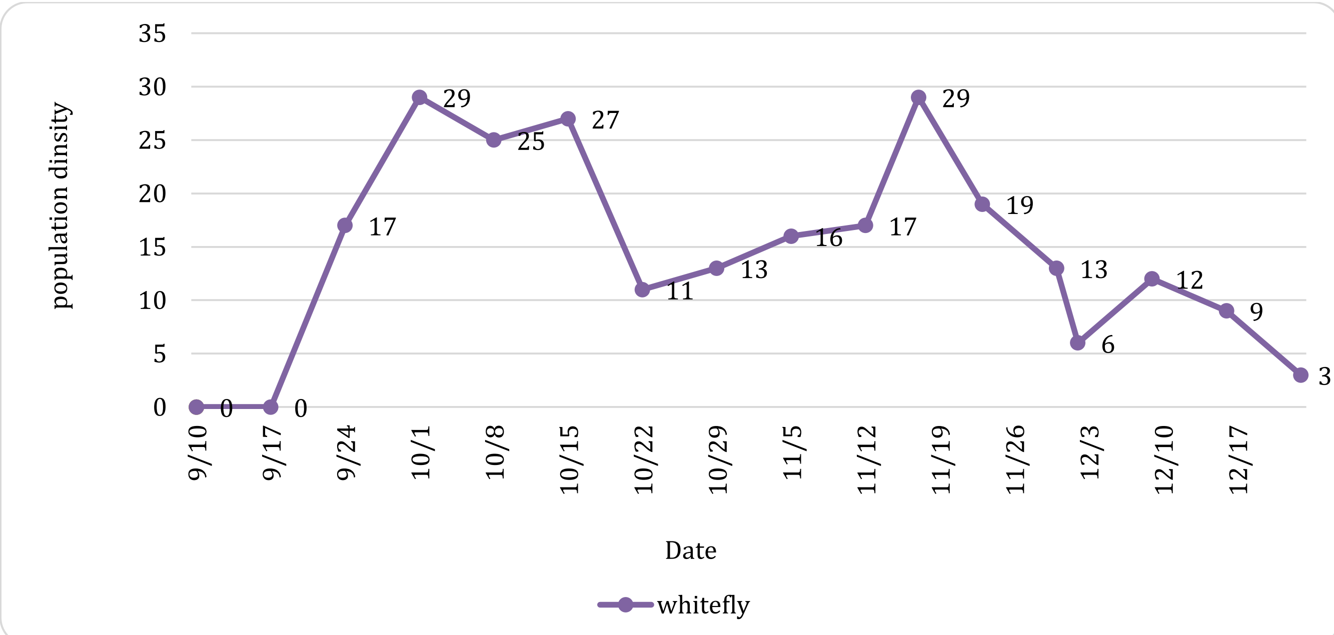


Figure 3: Whitefly population density on broccoli (*Brassica oleracea*).

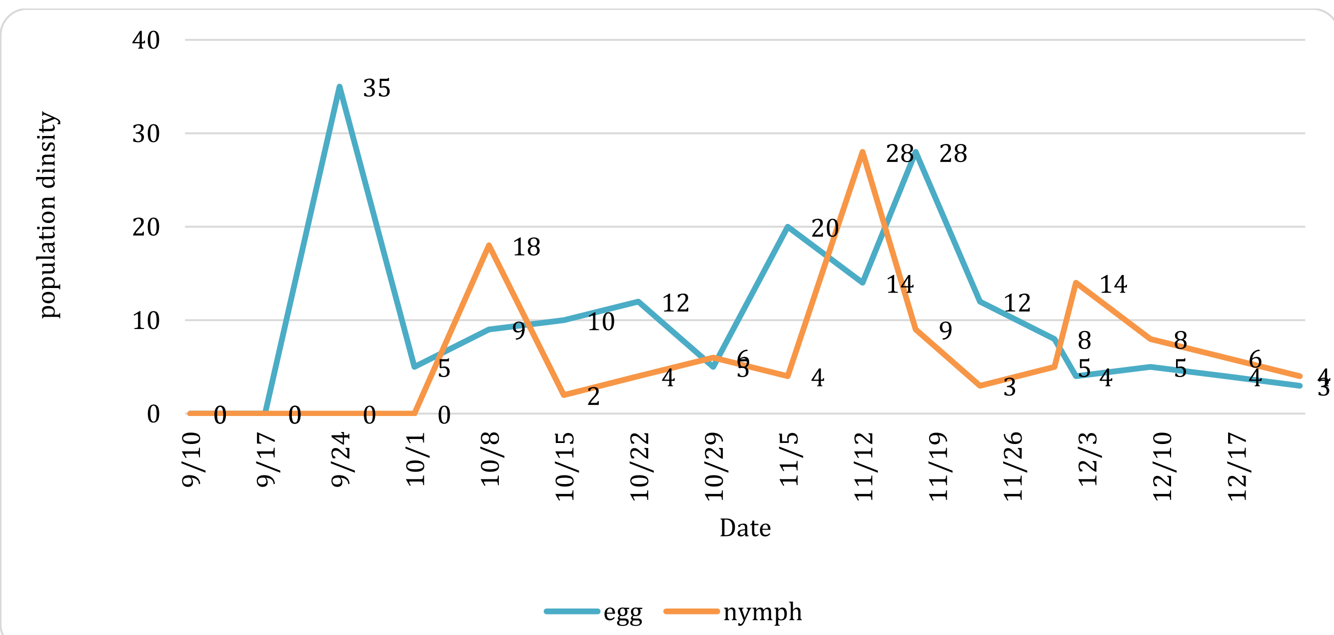


Figure 4: The population density of *Tetranychus urticae* eggs and nymphs on broccoli (*Brassica oleracea*).

Regarding nymph densities, fluctuations between rising and falling were observed. Peaks included 18 nymphs/leaf on October 8, followed by a decrease to 4 nymphs/leaf on October 22, an increase to 28 nymphs/leaf on November 12, and variations to 3 and 5 nymphs/leaf on November 23 and 30, respectively. Numbers increased to 14 nymphs/leaf on December 2 and then decreased to 4 nymphs/leaf on December 23 with the progression of plant growth stages, especially during the stage of stiffness and yellowing of leaves. The high density of mites during the last stages of crop growth can be attributed to the decrease in the nutritional content of plant leaves, rendering them unsuitable for egg laying. The study recorded natural enemies, including aphid lion (*Chrysoperla carnea*), leafminer parasitoid *Diglyphus isaea*, and *Eretmocerus mundus* (Table 1).

Table 1: Natural enemies on broccoli (*Brassica oleracea*).

Order	Family	Parasite
Neuroptera	Chrysopidae	*Chrysoperla carnea*
Hymenoptera	Eulophidae	*Diglyphus isaea*
Hymenoptera	Aphelinidae	*Eretmocerus mundus*

The majority of these leaf miners inflict damage on host plants through larvae mining and feeding on the mesophyll of leaves, and by females puncturing leaves with their ovipositors, feeding on exuding sap, thereby contributing to a reduction in photosynthesis (Parrella et al., 1985). Whiteflies can directly reduce crop yield and economic value by using them as food and indirectly by transmitting viruses (Kumar et al., 2021). Spider mites feed on host plants by inserting their stylets into leaf tissue, removing cell contents, resulting in the destruction of chloroplasts, loss of leaf chlorophyll, and a reduction in the net photosynthetic rate (Park and Lee, 2002).

Observing the figures that depict pest numbers, it becomes evident that several peaks and fluctuations exist. These may be attributed to both weather changes and the growth of the crop. Crops are known to produce secondary compounds influencing insect attraction or repulsion. Conducting experiments to understand these secondary metabolites and their relationship to insect densities is advisable.

The two-spotted mite was previously recorded on potatoes (*Solanum tuberosum*) during two-season plantations in Baghdad, Iraq (Kathiar et al., 2019). In Duhok province, Iraq, various pests were documented on broccoli crops, including cabbage grey aphid, cabbage white butterfly, great white butterfly, diamondback moths, cabbage cutworm, and grasshopper (Karso et al., 2022). Green lacewings emerge as potential biological control agents, commonly available in bio-factories (Medina et al., 2003). Additionally, the leaf miner parasite, a small wasp seeking out leaf miners for oviposition, was detected. Four hymenopteran parasites on squash and tomato crops, including *D. isaea*, *D. crassinervis*, *Pediobius metallicus*, and *Neochrysocharis formosa*, played a significant role in decreasing leaf miner infestation below the economic threshold (Kathiar et al., 2018).

In summary, understanding the pests affecting agricultural crops and causing economic losses is crucial. Assessing their levels allows the release of natural enemies, particularly through biological control. Diagnostic studies exploring secondary compounds produced by crops and their impact on insect attraction or repulsion provide valuable insights. Utilizing such compounds as materials to attract natural enemies can enhance pest control strategies.

AUTHORS' CONTRIBUTIONS

Sawsan Kareem Fliah, Nabaa Abdul Redha Mukheif, Sand oolaf Abud Kathiar conceived the idea, planned and designed the studies, executed the experiments, collected and analyzed the data, wrote the manuscript and edited it.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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