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Field Evaluation Efficacy of Acetamiprid Preparation against Bird Cherry-Oat Aphid (Rhopalosiphum Padi L.) and Impact on its Parasitoids

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Annotation: The bird cherry-oat aphid species (Rhopalosiphum padi L.) is the most frequent pest of winter wheat (Triticum aestivum L.). For the last few years, the attack of aphids on cereal crops has been increasing in Iraq, reducing cereal crop production [4]. Many types of pesticides have been used in wheat cultivation to control pests, and they are expensive, which causes social and environmental problems. There is an increasing demand to reduce the use of chemical insecticides and to search for ways and technologies to legalize and increase the efficiency of pesticides that affect pests while minimizing environmental damage. As a result, this study aimed to evaluate new acetamiprid preparations for application to the bird cherry-oat aphid (Rhopalosiphum padi L.). An experiment was performed to evaluate the effectiveness of six preparations on R. padi; it was observed that the new treatments have a close effect on the treatment of standard pesticide acetamiprid (ACT) and outperform it in one treatment, as shown in the treatment of (acetamiprid suspension) nanocapsules coated with chitosan (NCTCH). It also has little effect on parasitism and parasites in the field. New acetamiprid preparations are effective in killing the roles of wheat aphids, and they are environmentally friendly compounds that can be adopted in integrated pest management programs.

Keywords: Rhopalosiphum padi L., new formulations of insecticides, acetamiprid, parasitoids.

Introduction

Wheat (*Triticum aestivum L.*) It is a nutritious and economical dietary source. Wheat provides twenty percent of the world's food calories and feeds approximately 40 % of the world's population. [2]**.** Wheat is preferred over other food products in different countries. [2]**.**Wheat occupies more than 23% of the world's agricultural land. Its economic significance has grown in the baking, dietary, pharmaceutical, and other industries. It is also an essential commodity in the international market [2]. Several insect pests attack wheat crops from sowing to harvest, but aphids are the most dangerous and harmful among them. Aphids are economically significant pests of wheat in most wheat-growing regions worldwide, including Iraq [4]. *Schizaphis graminum* (Rond), *Rhopalosiphum padi* (L.), *Rhopalosiphum maidis* (Fitch), and *Diuraphis noxia* (Mordw) are among the primary aphid species found in Iraq [3]. *R. Padi* (L.) is one of the most frequently infesting species of wheat, reducing yield by up to 15% [4]. *R. Padi* (L.) is the most common aphid species inhabiting wheat. This polyphagous sucking insect is widespread globally [4]. The infestation period occurs in early spring in wheat fields, where the aphids primarily extract sap from shoots and leaves, leading to deformation, curling, and chlorosis of leaf growth [4]. It also spreads viral and fungal infections, reducing productivity by up to 80% due to disease [4]. It not only serves as a vector for Barley Yellow Dwarf Virus (BYDV) but also causes direct damage to plants by injecting a chemical substance. Contained in its saliva and is extracted by extracting sap, as well as causing indirect damage to the entire crop due to excessive honeydew production [4]. Controlling this pest is crucial. Physical, cultural, mechanical, host plant resistance, biological, and chemical control methods have been documented. In the current scenario, chemical pesticides are an effective strategy for managing this harmful aphid species [4]. Many natural enemies are associated with aphids, often maintaining a balance within the pest community. Numerous species of parasitoids have been reported to regulate aphid populations when environmental conditions are favorable [5]. Given the economic importance of these insects due to their increased density in recent years and their spread across wheat-growing areas in Iraq, as well as in line with previous studies, the present research aimed to evaluate the field efficacy of acetamiprid against the aphid *Rhopalosiphum padi* (L.) and its impact on its parasitoids.

The study aimed to establish the effect of some tested preparations on (Turtle aphids) and their parasitoids.

Materials and Methods

Chemicals and acetamiprid (95%) were obtained from the National Center for Pesticide Control, Ministry of Agriculture (Abu Ghraib, Baghdad, Iraq). Following the method developed by Sugumar et al. with some modifications, six formulations were prepared with three concentrations for each formulation, as specified in Table 1, in addition to the standard pesticide [9]. The formulations included (acetamiprid suspension) chitosan-coated nanocapsules (NCTCH), (acetamiprid suspension) polyethylene glycol-coated nanocapsules (NCT.PEG), (acetamiprid active ingredient powder) chitosan-coated nanocapsules (NCCHAI), (acetamiprid active ingredient powder) polyethylene glycol 6000-coated nanocapsules (NCAI.PEG), (acetamiprid suspension) nanoemulsion insecticide (NET), and (acetamiprid active ingredient powder) nanoemulsion (NEAI), in addition to the standard pesticide (ACT) [10][11]. The field experiment was conducted on a private farm in Abu Ghraib, Iraq, during the winter season of 2020-2021. The GPS coordinates were 33°23'45''N, 44°11'54''E, at 30 meters above sea level. The total area of the field was 2500 m^2. The winter wheat variety (Iba 99) was sown on November 17, 2020. The field was divided into experimental plots. The experimental area covered 300 square meters, with a plot size of 6 x 44 = 264 m^2. Each treatment plot measured 2 x 2 = 4 m^2, and each block covered 22 x 2 = 44 m^2. The number of treatments per block was 22, and the treatments were distributed across replicates according to a Randomized Complete Block Design (RCBD). Following pre-spray sampling, the formulations were sprayed when an increase in wheat aphid density was observed. The spraying process was carried out using a Matabi Super Green 16 pump sprayer with a capacity of 16 liters, adjusted to 3 bar pressure (Figure 1).

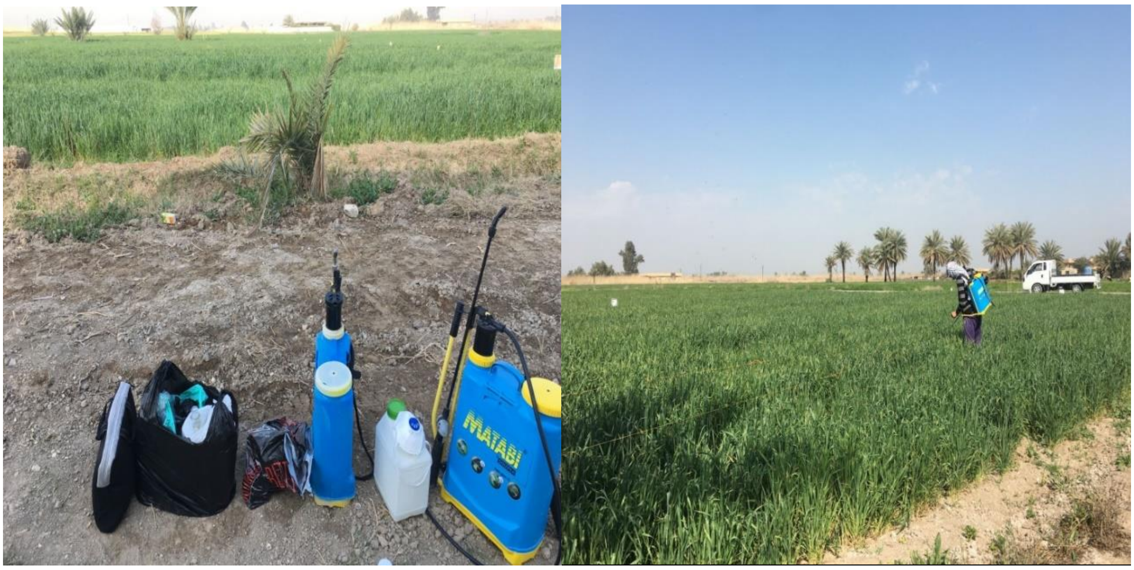

Figure 1. Land preparation and spraying with a Matabi Super Green 16 sprayer. This figure illustrates the land preparation and treatment application process using a Matabi Super Green 16 sprayer during the field experiment.

Results and Discussion

The results presented in (Table 2) show that the biological efficacy of the formulations against *Rhopalosiphum padi* (L.) followed the order (NCAI.PEG, NCT.PEG, NCCHAI, NCTCH, NEAI, NET, and ACT), achieving average efficacy rates of 70.51%, 76.14%, 82.44%, 83.12%, 81.91%, 78.26%, and 84.17%, respectively, with significant differences at the 0.05 probability level. The results indicate the superiority of chitosan-coated suspension nanocapsules (NCTCH), followed by the standard treatment (ACT). Statistical analysis also revealed that the new formulations have effects comparable to the standard treatment (ACT) and even surpass its efficacy in some cases, as demonstrated by the chitosan-coated suspension nanocapsules (NCTCH). The percentage of biological efficacy was calculated using the Henderson and Tilton formula [12]. The results also showed differences in biological efficacy across concentrations for each treatment, with efficacy rates for (C1, C2, and C3) reaching 81.22%, 74.33%, and 77.12%, respectively, with significant differences between them at the 0.05 probability level. The time factor also influenced the results, with efficacy rates recorded at 68.33%, 83.32%, 74.12%, 70.11%, 63.22%, and 47.89% at 24 hours, 3 days, 7 days, 10 days, 14 days, and 21 days, respectively, with significant differences. Notably, the biological efficacy of the nano-formulations and the conventional pesticide was influenced by factors such as time, the type of nano-formulations, and their concentrations, as evidenced by significant interactions [13]. The results presented in Table 3 demonstrate the impact of the formulations, prepared using different methods, on parasitism and the population of aphid mummies before treatment and at 24 hours, 3 days, 7 days, 10 days, 14 days, and 21 days after treatment. As shown in Table 3, the simple effect of the treatments on parasitism is evident from the number of mummies in the field compared to the standard parameter (ACT), which significantly reduced parasitism. These formulations, which have the least impact on natural enemies, can be applied in situations where rapid control of wheat aphids is required. The difference in biological efficacy among the formulations is attributed to the importance of nanoparticle size and shape, among the most critical factors determining these particles' physical, chemical, and biological properties [14].

Table 1. First, second, and third concentrations for each treatment.

Concentration of processing			
Concentration			
Processing	C1	C2	C3
NCAI.PEG	15 gm / 10 L	30 gm / 10 L	60 gm / 10 L
NCT.PEG	4 gm / 10 L	8 gm / 10 L	16 gm / 10 L
NCCHAI	55 ml / 10 L	110 ml / 10 L	220 ml / 10 L
NCTCH	55 ml / 10 L	110 ml / 10 L	220 ml / 10 L
NEAI	22.5 ml / 10 L	45 ml / 10 L	90 ml / 10 L
NET	4 ml / 10 L	8 ml / 10 L	16 ml / 10 L
ACT	1.25 ml / 10 L	2.5 ml / 10 L	5 ml / 10 L
Cont	10 L	10 L	10 L

Table 2. Biological efficacy of preparations on Rhopalosiphum padi (L.) population density at 24 hours, 3, 7, 10, 14, and 21 days after treatment preparation in wheat fields in the 2021 harvest season.

Number of Aphid Mummies							
Treatment	NCAI.PEG **70.51**	NCT.PEG **76.14**	NCCHAI **82.44**	NCTCH **83.12**	NEAR **82.91**	NET **78.26**	ACT **84.17**
Concentration	C1 **81.22**		C2 **74.33**		C3 **77.12**		
Time	**24hours** 68.33	**3Day** 83.32	**7Day** 74.12	**10Day** 70.11	**14Day** 63.22	**21Day** 47.89	

Table 3. Effect of treatment on the number of aphid mummies before treatment, 24 hours, 3, 7, 10, 14, and 21 days after treatment. Wheat fields for the 2021 harvest season.

Number of Aphid Mummies							
Treatments	NCAI.PEG 6.84	NCT.PEG 6.88	NCCHAI 7.17	NCTCH 7.67	NEAR 6.22	NET 6.55	ACT 4.22
Concentration	C1 6.68		C2 5.01		C3 3.72	Control 9.03	
Time	Before application 8.57	24hours 4.01	3Day 6.89	7Day 5.33	10Day 4.22	14Day 4.11	21Day 4.00

Conclusions

As a result of the scientific research conducted to evaluate the efficacy of acetamiprid formulations against the bird cherry-oat aphid (Rhopalosiphum padi) and their impact on its parasitoids, the following objectives were achieved: Reduction in the use of chemical pesticides in wheat fields, except in cases of severe infestation, by replacing them with low-toxicity formulations that are less harmful to natural enemies. Exploration of potential technological applications for developing pesticide formulations with properties such as slow release, enhanced solubility, permeability, and stability. These properties are primarily achieved by protecting encapsulated active ingredients from premature degradation or increasing their efficacy in pest control over an extended period. Thus, it is evident that acetamiprid formulations can reduce dosage and human exposure, making them environmentally friendly and capable of protecting crops. Expansion of extensive research on natural enemies of aphids present in wheat crops, identifying the most effective species, including parasitoids, which were mentioned and included as one of the components of integrated pest management programs for wheat production to facilitate mass cultivation.

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