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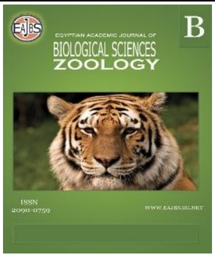

The Frequency of Insect Fauna, Other Pests, and Associated Natural Enemies in Quinoa (*Chenopodium quinoa Willd.)*

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ABSTRACT

The available data shows that Egypt has not conducted a thorough investigation into insect pests that impact quinoa. The main objective of this study was to identify and categorize insects and other natural enemies of quinoa in the Fayum Government. In four categories—insect pests, other pests, insect natural enemies, and spider natural enemies—a variety of new records have been recorded. The fauna was divided into two class-taxonomy categories, insect and miscellaneous, in addition to three behavioral categories: pest (P), natural enemy (N), and other (O). These groups of animals have diverse roles in the environment, including eating excrement, breaking down organic matter (fungivores), producing honey, and decomposing organic matter. Thirty-five insect species were found in the data during each of the two seasons; 22 of these insect species were pests, 9 were natural enemies, and 4 were categorized as other. The insect pest species (P) *Monomorium pharaonic*, *Myzus persicae*, and *Schizomyia buboniae* were the most significant, followed by *Cataglyphis savignyi* (O), which feeds on dead insects in the soil, and then the natural enemies (N) *Philonthus longicornis*, *Paederus aliferii*, and *Kleidotoma* sp. In the miscellaneous group, Collembola species were highly significant, followed by the true spiders *Sengletus extricates*, *Wadicosa fidelis*, and *Pardosa* sp. Quinoa cultivation faces many challenges, such as climate change, that require the production of more food of higher quality and quantity to combat global hunger and improve food security and safety.

INTRODUCTION

Given that the world's food security is currently threatened by the consequences of climate change and the limited resources facing some countries, the need for crops has led to

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the emergence of new nontraditional foods for agriculture. Quinoa (*Chenopodium quinoa* Willd), (family: Amaranthaceae) is considered one of the most promising crops of the future, complementary rather than alternative, to fill a portion of the world's nutritional gap. *C. quinoa* is an annual herbaceous plant belonging to the genus *Chenopodium*, which is the most diverse in the Chenopodiaceae family, among 250 species worldwide (Vega-Gálvez *et al.* 2010; Bazile *et al.* 2016; Vazquez-Luna et al. 2019). Quinoa is a dicotyledonous pseudocereal, not a true grain (Sharma *et al.* 2015), and contains all the essential amino acids. The percentage of protein content, which varies among species, ranges from 12–20%, which is approximately equivalent to the same amount found in milk; quinoa also contains carbohydrates, moisture, fats, and minerals in percentages ranging from 60–69%, 9-12.6%, 4-10%, and 3-4%, respectively, along with 10% fiber, according to previous studies (Sezgin and Sanlier 2019)**.** The quinoa plant has the ability to produce high-quality grains, which are considered to be the most nutrient-dense "grain" in the world. For this reason, it is known as the "mother of grains" owing to its protein quality and content, as well as that of the essential amino acids, such as threonine and methionine, and its high lysine content; moreover, it is rich in minerals and vitamins (Zikankuba *et al.*, 2017; Fu *et al.*, 2020)**.** It also contains other essential compounds that may have nutritional benefits, such as polyphenols and flavonoids (Montemurro *et al.*, 2019). The seed protein content may reach 22%, depending on the variety and its growth conditions, which is a higher percentage than that found in other grains, such as wheat, barley, rice, and maize. The ash yield of quinoa exceeds 3.5%, which is higher than that of other grains, such as rice, wheat, and maize, with ash yields of 0.5%, 1.8%, and 1.7%, respectively (Konishi *et al.*, 2004; Miranda *et al.*, 2012)**.** It is also richer in ascorbic acid, β-carotene, vitamins such as vitamin C, and minerals such as Ca, Fe, Mn, Mg, Cu, and K relative to those grains (Lazarte *et al.*, 2015). The fat content of quinoa seeds is greater than that of other grains and may reach 10% (Sharma *et al.*, 2015)**.** It also represents a good source of dietary fiber, with a fiber content of up to 3.8% (Koç and Çetin 2020). In addition, its carbohydrate contents consist of 5% sugar and 58% to 68% starch, which makes it an ideal source of energy (Bazile *et al.*, 2016). In addition to quinoa seeds being used for feeding, quinoa leaves are also considered a vegetable of high nutritional value (Adamczewska-Sowińska *et al.*, 2021). In fact, their richness, which provides a better nutritional feature, may compete with that of grains, as the protein content in young dry quinoa leaves (30–45 days old) is as high as 37.0. g , which is a higher amount than that found in the grain (Pathan and Siddiqui 2022), with a protein content of up to 15.7 g; in addition, the leaves are richer in essential minerals such as iron (Fe), zinc (Zn), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) compared to quinoa grains, whereas the fat and carbohydrate contents of green quinoa leaves are up to 4.5% and 34.0%, respectively, lower than the content found in quinoa seeds (up to 7.6% and 69.8%, respectively) (Adamczewska-Sowińska *et al.*, 2021; Pathan and Siddiqui 2022; Le *et al.*, 2021), all of which increase the nutritional value of quinoa leaves. This finding is positive for human health because it does not increase the level of glucose in the plasma due to its content, i.e., a high percentage of protein and a low percentage of carbohydrates. Quinoa leaves also contain vitamin A and vitamin E and are considered good sources of vitamin C, and the sprouts and their green leaves also contain carotenoids and xanthophylls (Le *et al.*, 2021, Kozioł 1992). Moreover, the content of carotene in quinoa leaves is greater than that in spinach and amaranth leaves, while the moderate level of fiber in quinoa leaves is close to that in spinach leaves, which contributes to its overall nutritional value (Yadav *et al.*, 2018). Quinoa leaves are thus a very nutritious vegetable that is traditionally consumed in many countries (Wan *et al.*, 2022).

Owing to its gluten-free nature, the quinoa crop offers those with celiac disease an option. Therefore, it can be used as a good source of food that meets the compensatory nutritional needs of patients with digestive disorders due to the intake of protein and carbohydrates. In addition, it contains twice the amount of fiber found in other grains, making it very useful in the digestive process (Bilgiçli and İbanoğlu 2015 Nov;Nowak *et al.,* 2016).

The Food and Agriculture Organization therefore organized a regional quinoa project that aimed to familiarize countries such as Egypt, Algeria, Iraq, Iran, Sudan, Mauritania, Lebanon, and Yemen with the quinoa crop and its production. Quinoa leaves are used for many medicinal purposes; in addition to their analgesic effects, they also have antiseptic, antimicrobial, and anti-inflammatory effects, which help in wound healing, and are also used as disinfectants of the urinary tract (Graf *et al.,* 2015; Tang and Tsao 2017

Moreover, the antioxidant components found in its leaves slow the proliferation of cancer cells (LE 2009; Meneguetti *et al.,* 2011). Its functional properties also include its cholesterol-lowering effect and its ability to inhibit high blood pressure, which helps protect against cardiovascular diseases (Scalbert *et al.* ,2005; Farinazzi-Machado et al. 2012), which opens the possibility of its use in the future as a medicinal crop. The fact that quinoa possesses this ideal content of nutrients in the absence of gluten makes it a very suitable nutritional supplement for vegetarians, athletes, children, elderly individuals, women at risk of osteoporosis, and people at risk of anemia and obesity**.** Therefore, the Food and Agriculture Organization considers it the "perfect food", and it has become referred to as a "superfood." The United Nations General Assembly also declared 2013 the "International Year of Quinoa" because of its importance.

There are many uses of quinoa, such as industrial applications, where saponins are utilized to make detergents, hair shampoo, dyes, firefighting chemicals, and fungicides (Gómez-Caravaca *et al.,* 2014). In addition, its use to feed livestock (Vidueiros *et al.,* 2015) makes it a reliable economic product, as its commercial exploitation can constitute an important tool for increasing income in many countries, especially developing and poor countries with limited food production that are forced to receive food aid, where it can contribute to alleviating poverty and combating food insecurity through its use as a strategic crop to supplement the diet in marginalized areas where most of the population suffers from malnutrition.

Compared with other crops, quinoa also has a high ability to adapt to harsh weather and different environments that present great difficulty and lead to a reduction in yield (El-Naggar *et al.,* 2018; Katwal and Bazile 2020)**.** It is likely that the production of quinoa is not particularly impacted by sharp differences in temperature between day and night (Hinojosa L *et al.,* 2019). The global temperature increase, which, according to climatic predictions, will continue to increase from 1.5 °C to 6 °C until the end of the XXI century, has been the greatest issue for agriculture in recent years (Shukla *et al.,* 2018). High temperatures do not affect the various uses of quinoa in the same ways, so it is possible to consider planting quinoa in various locations. Therefore, considering that quinoa is grown for both human food and animal feed, new ideas on how to use quinoa in regions that are most affected by climate change have been developed (García-Parra *et al.,* 2020). The quinoa plant is one of the most promising crops with high importance and has recently undergone great expansion in cultivation globally, where its occurrence in the global market is close to 84% (Bazile *et al.,* 2016; Jager 2015).

In Egypt, quinoa was introduced for the first time in 2005, where it was grown in South Sinai, and since 2010, the area cultivated with quinoa has reached more than 80 feddans (Nanduri *et al.,* 2019)**.** Quinoa can play an important role in food production in deserts and reclaimed lands in Egypt (Adel 2020), approximately one and a half million km^2. Most of this area is under hyperarid climatic conditions, and only 3% used in agriculture (El-Ramady *et al.,* 2013). Therefore, the Egyptian Ministry of Agriculture launched a national campaign to expand quinoa cultivation. This campaign may contribute to reducing dependence on wheat imports in the future, where the total production of wheat is sufficient for only 55% of Egypt's needs. Owing to the large gap in wheat production, the search for suitable alternatives to fill this gap has become necessary in addition to the possibility of using young quinoa plants as a new vegetable in Egypt (Abd El-Samad *et al.*, 2018).

In general, crop productivity is expected to be affected by global climate change, as this change is followed by a change in the number of pests that infest these crops, causing an economic impact that represents a major challenge for farmers and consumers worldwide. Despite its wide adaptability, quinoa has a wide range of pests known to infest it worldwide, causing crop losses (Rasmussen *et al.*, 2003; Sigsgaard *et al.*, 2008; Amber *et al.*, 2021).

By using only yellow sticky traps to track insect populations, an experiment was conducted at El Giza Research Station, Egypt, on the Masr 1 variety during the 2017 and 2018 seasons. *Aphis craccivora, Empoasca decipiens,* and *Bemisia tabaci* were the three principal pests found. Aphids and potato leafhoppers were the most prevalent pests (Adel 2020).

The present study provides a broad overview of the phenology of quinoa, especially its relationship with major insect pests and their natural enemies.

MATERIALS AND METHODS

The survey was carried out in Fayoum governorate, Ibshway region (29.38194º N, 30.70722º E), from November to April during two successive winter seasons, 2020-2021 and 2021-2022. Commercial quinoa variety (Egypt 1) was used in this study in an area of 1000 m^2. The quinoa seeds were sown during the first week of November in the two seasons in randomized complete block design with three replicates of 300 m^2. Pitfall traps and swiping nets were used in a zigzag pattern to collect data.

A pitfall trap can be made from any plastic container, usually filled with water and detergent, buried in the ground with its rim level with the ground (Macfadyen 1962; Naranjo 2008). Every pitfall trap used in this study is replaced every 15 days. Arthropods that typically walk or crawl along the ground have the potential to fall into the container and become trapped. Afterward, the arthropods were gathered and identified and kept in a vial with 70% ethyl alcohol and several droplets of glycerin. An arthropod sweep net was used for cleaning through the foliage and catching flying or resting arthropods. The collected arthropods, i.e., insects and spiders, were placed into a container and identified (Pedigo *et al.*, 1994)**.**

Arthropod collection began 14 days after sowing, and the specimens were maintained in a sample vial with 98% ethyl alcohol. The arthropods trapped via both methods were collected and examined, and identification at the species level was conducted via the Global Biodiversity Information Facility (GBIF) and other certain taxonomic keys (South 1961; Soto-Adames *et al.*, 2008; Akhtar *et al.*, 2013).

Juvenile spiders were mostly identified, and the systematic arrangement of Arachnida was conducted according to previous research (Prószyński 2003; Huber 2005; Platnick 2012) down to the family level.

Statistical Analysis of The Data:

The data were input into a computer and analyzed via the IBM SPSS software package version 20.0. **(**Armonk, NY: IBM Corp.**)**. The quantitative data are expressed as the means and standard deviations. One-way ANOVA was used to compare the different studied groups, followed by a post hoc test (Tukey) for pairwise comparisons. The significance of the obtained results was judged at the 5% level.

RESULTS AND DISCUSSION

The fauna was classified into two categories based on class-taxonomy, insect and miscellaneous, and into three categories according to their behavior, i.e., pest (P), natural enemy (N), and other (O), constituting different roles in the environment such as decomposing organic matter (fungivore), fragmenting organic matter, feeding on dung, and producing honey.

A total of 35 insects were identified throughout the two seasons: 22 pest species, 9 natural enemies, and 4 others, as shown in Tables 1a and 1b and Figure 1. The data are presented alphabetically by order as follows:

1. **Coleoptera** *(Philonthus longicornis, Paederus aliferii, Calosoma chloristictum, Coccinella undecimpunctata, Hydrophilus piceus, Blaps polychresta, Tropinota squalida,* and *Chiron cylindrus*).
2. **Diptera** (*Schizomyia buboniae Bradysia impatiens, Drosophila melanogaster, Sarcophaga carinaria, Simulium sp, Tabanus taeniola, Culex pipiens*).
3. **Hemiptera (***Nezara viridula*).
4. **Homoptera (***Myzus persicae, Aphis gossypii, Empoasca decipiens*).
5. **Hymenoptera (***Monomorium pharaonic, Cataglyphis savignyi, Apis mellifera, Diaeretiella rapae, Aphidius colemani, Pimpla roborator, Kleidotoma sp, Evania appendigaster, Vespa orientalis*).
6. **Lepidoptera (***Spodoptera exigua, Tuta absoluta*).
7. **Orthoptera (***Gryllus domesticus, Pyrgomorpha conica, Eyprepocnemis plorans).*
8. **Thysanoptera (***Haplothrips tritici, Thrips tabaci).*

In the first season, the insect pest species (P) *Monomorium pharaonic, Myzus persicae* and *Schizomyia buboniae* presented the greatest significance, with the latter two sharing the same level of significance, followed by *Cataglyphis savignyi* (O), which feeds on dead insects in the soil, and then *Philonthus longicornis, Paederus aliferii,* and *Kleidotoma* sp., which are natural enemies (N) (Table 1a). The data collected in the second season closely mirrored those of the first: *Monomorium pharaonic, Myzus persicae,* and *Schizomyia buboniae* presented the highest significance (P), followed by *Cataglyphis savignyi* (O) and then *Philonthus longicornis*, *Kleidotoma sp.*, and *Paederus aliferii* (N), as presented in Table 1b.It is clear from the results of the insect survey during the two seasons that the numbers of most insects doubled in the second season, and in many cases, they were three times as many, as in the pests *Hydrus piceus, Drosophila melanogaster, Culex pipiens, Nezara viridula, Aphis gossypii, Aphidius colemani, Pyrgomorpha conica*, and *Haplothrips tritici*, the natural enemies *Coccinella undecimpunctata, Diaeretiella rapae, Pimpla roborator,* and *Evania appendigaster,* and the other soil insects *Blaps polychresta* and *Chiron cylindrus*.

As presented in Table 2a, there were 19 individuals of miscellaneous fauna in the first season: 5 species were (O), i.e., 3 species from class Collembola, 1 from class Malacostraca, and 1 from class Diplopoda, as shown in Figure 2; the remaining 14 were (N) from class Arachnida and included 11 families (Fig 3).

The class Collembola is also called Entognatha because these species have internal mouthparts, has one order, including three individuals that belong to two families. The most significant level was observed for the Collembola species, followed by the true spiders *Sengletus extricates, Wadicosa fidelis,* and *Pardosa* sp. The diverse fauna primarily consists of predatory mites; their numbers are relatively stable, with a minor surge during the second season, as presented in Tables 2a & 2b.

The overall abundance of all the fauna was very similar in both seasons, so their presence was recorded monthly for each species, according to the previously mentioned classification: insects (a) and miscellaneous animals (b). The data from December revealed the (P) species *Schizomyia buboniae, Monomorium pharaonic,* and *Bradysia impatiens* and the (O) species *Cataglyphis savignyi* (Table 3a), and in terms of the miscellaneous fauna, only the Collembola species were present (Table 3b). In January, most fauna began to be found, as shown in Tables 4a and 4b; *Monomorium pharaonic, Schizomyia buboniae,* and *Myzus persicae* were recorded as highly significant pests. In addition to the presence of seven N insects, the most significant populations were those of *Kleidotoma* sp. and *Philonthus longicornis* and all of the true spiders, especially *Sengletus extricates* and *Wadicosa fidelis,* with the same high level of significance. Midseason, i.e., in February, the insect pests with the greatest abundance were *Monomorium pharaonic* followed by *Myzus persicae*. The activities of insect natural enemies were highest for *Schizomyia buboniae* and *Philonthus longicornis,* and the continued presence of *Kleidotoma* sp. and many N species was noted, albeit with slightly smaller populations than in January, as shown in Table 5a. Table 5b shows three highly significant spider species (N) (*Sengletus extricates*, *Wadicosa fidelis*, and *Pardosa* sp.), plus the presence of other spiders with a low population and greater significance. As shown in Table 6a, the insect fauna changed; three pests were still present in excess in large numbers: *Monomorium pharaonic, Myzus persica,* and *Empoasca decipiens*, and gradually became significant. On the other hand, there was an increase in natural enemies such as *Philonthus longicornis* and *Paederus aliferii;* additionally, *Pimpla roborator* and *Evania appendigaster* started to occur, whereas the others (N) decreased in population. As shown in Table 6b, in the previous month, the greatest abundance was for three spiders (N) (*Sengletus extricates*, *Wadicosa fidelis,* and *Pardosa* sp.), the last of which tended to increase. At the end of each season, the insect fauna and other animal fauna tended to be absent, with the exception of a few insect pests, such as *Monomorium pharaonic, Myzus persica,* and *Empoasca decipiens,* and natural enemies, such as *Philonthus longicornis* and *Paederus aliferii,* and even *Pimpla roborator* and *Evania appendigaster* were still present in the field (Table 7a). Three true spiders were also present, with *Pardosa* sp., *Wadicosa fidelis*, and *Sengletus extricates* presenting the highest significance (Table 7b).

The data were similar to those of (Adel 2020), who reported three main pests: *Aphis craccivora, Empoasca decipiens* and *Bemisia tabaci*. The most common pest was aphids, followed by potato leafhoppers. our findings explain that no harm to the quinoa plants occured as expected for the current insect pests, possibly because the plant is naturally hispid with a thick, cylindrical stalk, and the presence of many natural enemies, including predatory insects, mites, and parasites, results in an excellent balance. This point was confirmed in that previous study (Adel 2020) as high numbers of parasitoids and predators were observed throughout the two seasons. In addition, Collembola species, which had the highest population, are crucial for the formation of the soil microstructure and the breakdown of plant litter. Numerous parasitic protozoa, nematodes, trematodes, and dangerous bacteria reside on these species as hosts, given the fact that they are in turn preyed upon by few predators. Many higher-quality genotypes of quinoa, which is considered resistant to abiotic and biotic stresses, (Haldar S *et al.,* 2021)

In Egypt, a comparable survey study was carried out in five governorates in 2015 (El-Moity *et al.,* 2015). At all locations, two aphid species, *Myzus persicae* and *Aphis gossypii*, were detected, and *Tuta absoluta* (Lepidoptera) was also detected in Fayum, Giza, and Ismailia. In Fayum governorate, *Sitophilus granaries* (Coleoptera), which did not appear in the present survey, and the cotton leaf worm *Spodoptera exigua* were also detected, which agreed with the findings of this study. *Nysius cymoides* and *Creontiades pallidus* (Hemiptera) were identified only in Ismailia, and *Phenacoccus solenopsis* (Hemiptera) was detected only in Giza. *Atherigona theodori* (Diptera) was detected on a few plants in Ismailia and Fayum governorate that were not recorded in the current study.

Table 1a: The population frequency of insect fauna for pests, natural enemies, and others in quinoa throughout the first season

Scientific name	**Mean ± SD.**
Philonthus longicornis	129.0c ± 6.93
Paederus aliferii	77.67d ± 3.06
Calosoma chloristictum	32.0fgh ± 1.0
Coccinella undecimpunctata	10.67ij ± 3.79
Hydrophilus piceus	14.67hij ± 3.51
Blaps polychresta	5.33j ± 0.58
Tropinota squalida	7.33ij ± 0.58
Chiron cylindrus	5.33j ± 0.58
Schizomyia buboniae	214.7b ± 19.73
Bradysia impatiens	43.33ef ± 5.51
Drosophila melanogaster	42.0ef ± 3.0
Sarcophaga carinaria	32.0fgh ± 4.36
Simulium sp.	73.0d ± 3.0
Tabanus taeniola	6.67ij ± 3.06
Culex pipiens	16.33ghij ± 2.89
Nezara viridula	1.67j ± 0.58
Myzus persicae	221.3b ± 2.31
Aphis gossypii	14.33hij ± 3.06
Empoasca decipiens	75.33d ± 7.23
Monomorium pharaonic	637.3a ± 13.32
Cataglyphis savignyi	135.0c ± 15.52
Apis mellifera	25.33fghi ± 0.58
Diaeretiella rapae	36.0f ± 2.65
Aphidius colemani	60.67de ± 4.04
Pimpla roborator	16.0ghij ± 2.65
Kleidotoma sp.	72.0d ± 5.0
Evania appendigaster	7.33ij ± 2.08
Vespa orientalis	9.0ij ± 4.36
Spodoptera exigua	3.0j ± 1.0
Tuta absoluta	11.67ij ± 5.13
Gryllus domesticus	1.33j ± 0.58
Pyrgomorpha conica	1.33j ± 0.58
Eyprepocnemis plorans	3.0j ± 2.65
Haplothrips tritici	34.33fg ± 3.51
Thrips tabaci	9.0ij ± 3.61
F	116.778*
P	<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-j) are not significant (OR means with totally different letters (a-j) are significant).

Fig. 1: samples from insect's fauna.

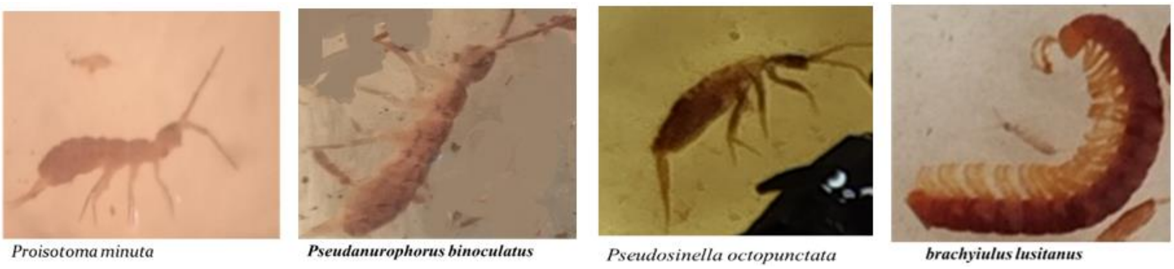

Fig. 2: samples from soil animal fauna.

Fig. 3: samples from different classes of true spiders.

Table 1b: The population frequency of insect fauna for pests, natural enemies, and others in quinoa throughout the second season**.**

Scientific name	**Mean ± SD.**
Philonthus longicornis	254.7d ± 1.15
Paederus aliferii	182.7ef ± 5.86
Calosoma chloristictum	75.33hi ± 6.43
Coccinella undecimpunctata	27.33klmn ± 3.06
Hydrophilus piceus	44.67jkl ± 5.03
Blaps polychresta	16.67klmn ± 1.15
Tropinota squalida	26.67klmn ± 3.06
Chiron cylindrus	16.0lmn ± 3.46
Schizomyia buboniae	408.3c ± 15.95
Bradysia impatiens	96.33gh ± 4.04
Drosophila melanogaster	112.7g ± 11.02
Sarcophaga carinaria	86.67hij ± 11.02
Simulium sp.	206.0e ± 8.0
Tabanus taeniola	14.67mn ± 4.16
Culex pipiens	45.33jk ± 6.11
Nezara viridula	9.33n ± 3.06
Myzus persicae	463.3b ± 4.16
Aphis gossypii	42.67jklm ± 2.31
Empoasca decipiens	157.3f ± 4.16
Monomorium pharaonic	1210.7a ± 38.66
Cataglyphis savignyi	283.0d ± 5.0
Apis mellifera	64.67ij ± 4.16
Diaeretiella rapae	96.0gh ± 5.29
Aphidius colemani	162.7f ± 8.08
Pimpla roborator	42.67jklm ± 6.43
Kleidotoma sp.	196.7e ± 17.01
Evania appendigaster	26.67klmn ± 4.62
Vespa orientalis	16.67klmn ± 3.06
Spodoptera exigua	6.0n ± 1.0
Tuta absoluta	19.0klmn ± 2
Gryllus domesticus	2.67n ± 0.58
Pyrgomorpha conica	3.0n ± 1.0
Eyprepocnemis plorans	5.67n ± 2.08
Haplothrips tritici	112.0g ± 2.0
Thrips tabaci	14.0mn ± 1.0
F	1793.566*
P	<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-n) are not significant (OR means with totally different letters (a-n) are significant).

Table 2a: The population frequency of miscellaneous fauna in quinoa throughout the first season.

Classification			Scientific name	Mean ± SD.
Class	**Order**	**Family**		
Arachnida	Araneae	Dictynidae	Unidetified sp.	30.67ef ± 1.15
		Dysderidae	*Dysdera crocota*	6.0g ± 1.0
		Gnaphosidae	*Micaria dives*	38.67e ± 3.51
		Linyphidae	*Sengletus extricates*	318.7c ± 8.96
		Lycosidae	*Wadicosa fidelis*	291.0d ± 7.55
			Pardosa sp.	276.0d ± 15.72
		Oecobiidae	*Oecbius* sp.	5.33g ± 1.53
		Philodromidae	*Thanatus albini*	6.33g ± 4.16
			Philodromus cespitum	6.67g ± 2.89
		Pholcidae	*Pholcus* sp.	4.33g ± 0.58
		Salticidae	*Thyene imperialis*	9.0g ± 2.65
		Thomisidae	*Thomissus spinifer*	6.67g ± 1.15
			Auryopis sp.	20.67efg ± 0.58
		Thridiidae	*Enoplognatha gemina*	20.33efg ± 0.58
Collembola	Entomobryomorpha	Isotomidae	*Proisotoma minuta*	384.0a ± 15.62
			Pseudanurophorus binoculatus	353.7b ± 13.05
		Entomobryidae	*Pseudosinella octopunctata*	362.7ab ± 11.24
Diplopoda	Julida	Julidae	*Brachyiulus lusitanus*	26.33efg ± 3.06
Malacostraca	Isopoda	Agnaridae	*Hemilepistus reaumuri*	11.67fg ± 1.53
F				1348.600*
P				<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-g) are not significant (OR means with totally different letters (a-g) are significant).

Table 2b: The population frequency of miscellaneous fauna in quinoa throughout the second season.

Classification			Scientific name	Mean ± SD.
Class	**Order**	**Family**		
Arachnida	Araneae	Dictynidae	Unidetified sp.	31.33g ± 2.08
		Dysderidae	*Dysdera crocota*	9.33h ± 1.53
		Gnaphosidae	*Micaria dives*	43.67f ± 2.52
		Linyphidae	*Sengletus extricates*	335.7c ± 2.08
		Lycosidae	*Wadicosa fidelis*	310.3d ± 1.53
			Pardosa sp.	275.7e ± 5.03
		Oecobiidae	*Oecbius* sp.	7.0h ± 1.0
		Philodromidae	*Thanatus albini*	10.67h ± 1.53
			Philodromus cespitum	11.67h ± 1.53
		Pholcidae	*Pholcus* sp.	8.33h ± 0.58
		Salticidae	*Thyene imperialis*	12.67h ± 1.53
		Thomisidae	*Thomissus spinifer*	10.67h ± 2.08
			Auryopis sp.	29.33g ± 2.08
		Thridiidae	*Enoplognatha gemina*	29.0g ± 2.0
Collembola	Entomobryomorpha	Isotomidae	*Proisotoma minuta*	390.7a ± 9.02
			Pseudanurophorus binoculatus	359.3b ± 7.37
		Entomobryidae	*Pseudosinella octopunctata*	368.0b ± 7.0
Diplopoda	Julida	Julidae	*Brachyiulus lusitanus*	31.67g ± 2.08
Malacostraca	Isopoda	Agnaridae	*Hemilepistus reaumuri*	15.0h ± 1.0
F				5352.138*
P				<0.001*

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Table 3a: The mean population frequency of insect fauna on December

Scientific name	Mean ± SD.
Philonthus longicornis	0d ± 0
Paederus aliferii	0d ± 0
Calosoma chloristictum	0d ± 0
Coccinella undecimpunctata	0d ± 0
Hydrophilus piceus	0d ± 0
Blaps polychresta	0d ± 0
Tropinota squalida	0d ± 0
Chiron cylindrus	0d ± 0
Schizomyia buboniae	15b ± 1
Bradysia impatiens	2c ± 1
Drosophila melanogaster	0d ± 0
Sarcophaga carinaria	0d ± 0
Simulium sp.	0d ± 0
Tabanus taeniola	0d ± 0
Culex pipiens	0d ± 0
Nezara viridula	0d ± 0
Myzus persicae	0d ± 0
Aphis gossypii	0d ± 0
Empoasca decipiens	0d ± 0
Monomorium pharaonic	91a ± 1
Cataglyphis savignyi	15.67b ± 2.52
Apis mellifera	0d ± 0
Diaeretiella rapae	0d ± 0
Aphidius colemani	0d ± 0
Pimpla roborator	0d ± 0
Kleidotoma sp.	0d ± 0
Evania appendigaster	0d ± 0
Vespa orientalis	0d ± 0
Spodoptera exigua	0d ± 0
Tuta absoluta	0d ± 0
Gryllus domesticus	0d ± 0
Pyrgomorpha conica	0d ± 0
Eyprepocnemis plorans	0d ± 0
Haplothrips tritici	0d ± 0
Thrips tabaci	0d ± 0
F	2752.441*
P	<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-d) are not significant (OR means with totally different letters (a-d) are significant).

Table 3b: The mean population frequency of miscellaneous on December.

Classification			Scientific name	Mean ± SD.
Class	**Order**	**Family**		
Arachnida	Araneae	Dictynidae	Unidetified sp.	0d ± 0
		Dysderidae	*Dysdera crocota*	0d ± 0
		Gnaphosidae	*Micaria dives*	0d ± 0
		Linyphidae	*Sengletus extricates*	0d ± 0
		Lycosidae	*Wadicosa fidelis*	0d ± 0
			Pardosa sp.	0d ± 0
		Oecobiidae	*Oecbius* sp.	0d ± 0
		Philodromidae	*Thanatus albini*	0d ± 0
			Philodromus cespitum	0d ± 0
		Pholcidae	*Pholcus* sp.	0d ± 0
		Salticidae	*Thyene imperialis*	0d ± 0
		Thomisidae	*Thomissus spinifer*	0d ± 0
			Auryopis sp.	0d ± 0
		Thridiidae	*Enoplognatha gemina*	0d ± 0
Collembola	Entomobryomorpha	Isotomidae	*Proisotoma minuta*	20.67b ± 0.58
			Pseudanurophorus binoculatus	56a ± 1
		Entomobryidae	*Pseudosinella octopunctata*	12.67c ± 2.52
Diplopoda	Julida	Julidae	*Brachyiulus lusitanus*	0d ± 0
Malacostraca	Isopoda	Agnaridae	*Hemilepistus reaumuri*	0d ± 0
F				1364.502*
P				<0.001*

3 replicas for each group   Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-d) are not significant (OR means with totally different letters (a-d) are significant).

Table 4a: The population frequency of insect fauna on January.

Scientific name	Mean ± SD.
Philonthus longicornis	25ef ± 8.66
Paederus aliferii	12hijk ± 0
Calosoma chloristictum	16.33ghi ± 1.15
Coccinella undecimpunctata	3.67klm ± 1.15
Hydrophilus piceus	8ijklm ± 1.73
Blaps polychresta	0.67m ± 0.58
Tropinota squalida	4klm ± 1
Chiron cylindrus	0m ± 0
Schizomyia buboniae	121.7b ± 7.37
Bradysia impatiens	13.67hij ± 3.06
Drosophila melanogaster	6.67jklm ± 0.58
Sarcophaga carinaria	11.67hijk ± 0.58
Simulium sp.	30.33de ± 2.52
Tabanus taeniola	2.33lm ± 1.15
Culex pipiens	4klm ± 1.73
Nezara viridula	0m ± 0
Myzus persicae	93c ± 0
Aphis gossypii	4klm ± 1.73
Empoasca decipiens	9.67hijkl ± 0.58
Monomorium pharaonic	201.7a ± 6.51
Cataglyphis savignyi	16.33ghi ± 1.53
Apis mellifera	24efg ± 1
Diaeretiella rapae	11.33hijk ± 1.15
Aphidius colemani	13.33hij ± 1.53
Pimpla roborator	0m ± 0
Kleidotoma sp.	35.67d ± 2.08
Evania appendigaster	0m ± 0
Vespa orientalis	6.67jklm ± 2.52
Spodoptera exigua	0m ± 0
Tuta absoluta	0m ± 0
Gryllus domesticus	0m ± 0
Pyrgomorpha conica	0m ± 0
Eyprepocnemis plorans	0m ± 0
Haplothrips tritici	18fgh ± 3
Thrips tabaci	0m ± 0
F	750.212*
p	<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-m) are not significant (OR means with totally different letters (a-m) are significant).

Table 4b: The mean population frequency of miscellaneous fauna on January.

Classification			Scientific name	Mean ± SD.
Class	**Order**	**Family**		
Arachnida	Araneae	Dictynidae	*Unidetified* sp.	12fg ± 1
		Dysderidae	*Dysdera crocota*	2.67hi ± 0.58
		Gnaphosidae	*Micaria dives*	17f ± 1
		Linyphidae	*Sengletus extricates*	122a ± 2.65
		Lycosidae	*Wadicosa fidelis*	115a ± 5
			Pardosa sp.	38.67e ± 7.57
		Oecobiidae	*Oecbius* sp.	3hi ± 1
		Philodromidae	*Thanatus albini*	5ghi ± 2.65
			Philodromus cespitum	5ghi ± 1
		Pholcidae	*Pholcus* sp.	1.67hi ± 0.58
		Salticidae	*Thyene imperialis*	6.33ghi ± 1.53
		Thomisidae	*Thomissus spinifer*	4.67ghi ± 0.58
			Auryopis sp.	5.67ghi ± 0.58
		Thridiidae	*Enoplognatha gemina*	5.33ghi ± 0.58
Collembola	Entomobryomorpha	Isotomidae	*Proisotoma minuta*	57d ± 1
			Pseudanurophorus binoculatus	75.67c ± 2.52
		Entomobryidae	*Pseudosinella octopunctata*	94b ± 2
Diplopoda	Julida	Julidae	*Brachyiulus lusitanus*	0i ± 0
Malacostraca	Isopoda	Agnaridae	*Hemilepistus reaumuri*	8gh ± 1
F				827.285*
P				<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-i) are not significant (OR means with totally different letters (a-i) are significant).

Table 5a: The mean population frequency of insect on February

Scientific name	Mean ± SD.
Philonthus longicornis	37.33c ± 0.58
Paederus aliferii	17.33efg ± 1.15
Calosoma chloristictum	10.33gh ± 1.15
Coccinella undecimpunctata	4hij ± 1
Hydrophilus piceus	4.33hij ± 1.53
Blaps polychresta	3.67hij ± 0.58
Tropinota squalida	3.33hij ± 0.58
Chiron cylindrus	0j ± 0
Schizomyia buboniae	41.67c ± 8.33
Bradysia impatiens	24.67de ± 2.52
Drosophila melanogaster	22.33de ± 2.31
Sarcophaga carinaria	14.33fg ± 4.51
Simulium sp.	20def ± 1
Tabanus taeniola	1.67j ± 1.15
Culex pipiens	1.67j ± 1.53
Nezara viridula	0j ± 0
Myzus persicae	73b ± 2
Aphis gossypii	5hij ± 2.65
Empoasca decipiens	22def ± 3.61
Monomorium pharaonic	186a ± 6
Cataglyphis savignyi	22.33de ± 3.06
Apis mellifera	1.33j ± 0.58
Diaeretiella rapae	18.33ef ± 0.58
Aphidius colemani	21.67def ± 1.15
Pimpla roborator	0j ± 0
Kleidotoma sp.	27d ± 2
Evania appendigaster	0j ± 0
Vespa orientalis	2.33ij ± 2.08
Spodoptera exigua	0j ± 0
Tuta absoluta	0j ± 0
Gryllus domesticus	0j ± 0
Pyrgomorpha conica	1.33j ± 0.58
Eyprepocnemis plorans	1.33j ± 0.58
Haplothrips tritici	10ghi ± 1
Thrips tabaci	0j ± 0
F	598.537*
P	<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-j) are not significant (OR means with totally different letters (a-j) are significant).

Table 5b: The mean population frequency of miscellaneous on February.

Classification			Scientific name	Mean ± SD.
Class	**Order**	**Family**		
Arachnida	Araneae	Dictynidae	Unidetified sp.	12fgh ± 1
		Dysderidae	*Dysdera crocota*	2.67hi ± 0.58
		Gnaphosidae	*Micaria dives*	17f ± 1
		Linyphidae	*Sengletus extricates*	124c ± 2
		Lycosidae	*Wadicosa fidelis*	103.3d ± 1.53
			Pardosa sp.	91.67f ± 6.11
		Oecobiidae	*Oecbius* sp.	1.67hi ± 0.58
		Philodromidae	*Thanatus albini*	1.33i ± 1.53
			Philodromus cespitum	1.67hi ± 2.08
		Pholcidae	*Pholcus* sp.	2hi ± 0
		Salticidae	*Thyene imperialis*	2hi ± 1
		Thomisidae	*Thomissus spinifer*	2hi ± 1
			Auryopis sp.	13.67fg ± 0.58
		Thridiidae	*Enoplognatha gemina*	13.67fg ± 0.58
Collembola	Entomobryomorpha	Isotomidae	*Proisotoma minuta*	152.7a ± 10.69
			Pseudanurophorus binoculatus	95.33de ± 3.51
		Entomobryidae	*Pseudosinella octopunctata*	141b ± 5.57
Diplopoda	Julida	Julidae	*Brachyiulus lusitanus*	11.67fghi ± 1.53
Malacostraca	Isopoda	Agnaridae	*Hemilepistus reaumuri*	3.67ghi ± 0.58
F				800.732*
P				<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-i) are not significant (OR means with totally different letters (a-i) are significant).

Table 6a: The mean population frequency of insect on March.

Scientific name	Mean ± SD.
Philonthus longicornis	48.33b ± 2.52
Paederus aliferii	39.33cd ± 2.52
Calosoma chloristictum	5.33ijklm ± 0.58
Coccinella undecimpunctata	3jklm ± 3.46
Hydrophilus piceus	2.33klm ± 1.53
Blaps polychresta	1lm ± 1
Tropinota squalida	0m ± 0
Chiron cylindrus	5.33ijklm ± 0.58
Schizomyia buboniae	32.33de ± 9.87
Bradysia impatiens	1.67klm ± 0.58
Drosophila melanogaster	12.67ghi ± 1.15
Sarcophaga carinaria	3.67jklm ± 2.08
Simulium sp.	17.67fg ± 2.52
Tabanus taeniola	2.67klm ± 1.15
Culex pipiens	8hijklm ± 1
Nezara viridula	1lm ± 0
Myzus persicae	41.67bc ± 0.58
Aphis gossypii	4.67ijklm ± 1.53
Empoasca decipiens	33.33d ± 3.06
Monomorium pharaonic	131.3a ± 2.52
Cataglyphis savignyi	32de ± 1.73
Apis mellifera	0m ± 0
Diaeretiella rapae	6.33ijklm ± 1.15
Aphidius colemani	25ef ± 2
Pimpla roborator	15gh ± 2
Kleidotoma sp.	9.33hijk ± 1.15
Evania appendigaster	4.67hjklm ± 2.08
Vespa orientalis	0m ± 0
Spodoptera exigua	3jklm ± 1
Tuta absoluta	11ghij ± 4.58
Gryllus domesticus	1.33klm ± 0.58
Pyrgomorpha conica	0m ± 0
Eyprepocnemis plorans	1.67klm ± 2.89
Haplothrips tritici	6ijklm ± 1.73
Thrips tabaci	9hijkl ± 3.61
F	279.433*
P	<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-m) are not significant (OR means with totally different letters (a-m) are significant).

Table 6b: The mean population frequency of miscellaneous on March.

Classification			Scientific name	Mean ± SD.
Class	**Order**	**Family**		
Arachnida	Araneae	Dictynidae	Unidetified sp.	6.67c ± 0.58
		Dysderidae	*Dysdera crocota*	0.67c ± 0.58
		Gnaphosidae	*Micaria dives*	4.67c ± 2.52
		Linyphidae	*Sengletus extricates*	64.33bc ± 5.51
		Lycosidae	*Wadicosa fidelis*	62.67bc ± 5.03
			Pardosa sp.	113.3ab ± 5.86
		Oecobiidae	*Oecbius* sp.	0.67c ± 0.58
		Philodromidae	*Thanatus albini*	0c ± 0
			Philodromus cespitum	0c ± 0
		Pholcidae	*Pholcus* sp.	0.67c ± 0.58
		Salticidae	*Thyene imperialis*	0.67c ± 0.58
		Thomisidae	*Thomissus spinifer*	0c ± 0
			Auryopis sp.	1.33c ± 0.58
		Thridiidae	*Enoplognatha gemina*	1.33c ± 0.58
Collembola	Entomobryomorpha	Isotomidae	*Proisotoma minuta*	140ab ± 10.54
			Pseudanurophorus binoculatus	174.3a ± 109.7
		Entomobryidae	*Pseudosinella octopunctata*	96b ± 2.65
Diplopoda	Julida	Julidae	*Brachyiulus lusitanus*	14.67c ± 1.53
Malacostraca	Isopoda	Agnaridae	*Hemilepistus reaumuri*	0c ± 0
F				14.443*
P				<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-c) are not significant (OR means with totally different letters (a-c) are significant).

Table 7a: The mean population frequency of insect on April.

Scientific name	Mean ± SD.
Philonthus longicornis	18.33b ± 1.53
Paederus aliferii	9cde ± 1
Calosoma chloristictum	0f ± 0
Coccinella undecimpunctata	0f ± 0
Hydrophilus piceus	0f ± 0
Blaps polychresta	0f ± 0
Tropinota squalida	0f ± 0
Chiron cylindrus	0f ± 0
Schizomyia buboniae	4ef ± 1
Bradysia impatiens	1.33f ± 0.58
Drosophila melanogaster	0.33f ± 0.58
Sarcophaga carinaria	2.33f ± 3.21
Simulium sp.	5def ± 1
Tabanus taeniola	0f ± 0
Culex pipiens	2.67f ± 0.58
Nezara viridula	0.67f ± 0.58
Myzus persicae	13.67bc ± 1.53
Aphis gossypii	0.67f ± 0.58
Empoasca decipiens	10.33cd ± 0.58
Monomorium pharaonic	16b ± 1
Cataglyphis savignyi	48.67a ± 8.50
Apis mellifera	0f ± 0
Diaeretiella rapae	0f ± 0
Aphidius colemani	0.67f ± 1.15
Pimpla roborator	1f ± 1
Kleidotoma sp.	0f ± 0
Evania appendigaster	2.67f ± 1.15
Vespa orientalis	0f ± 0
Spodoptera exigua	0f ± 0
Tuta absoluta	0.67f ± 0.58
Gryllus domesticus	0f ± 0
Pyrgomorpha conica	0f ± 0
Eyprepocnemis plorans	0f ± 0
Haplothrips tritici	0.33f ± 0.58
Thrips tabaci	0f ± 0
F	90.238*
P	<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-f) are not significant (OR means with totally different letters (a-f) are significant).

Table 7b: The mean population frequency of miscellaneous on April.

Classification			Scientific name	Mean ± SD.
Class	**Order**	**Family**		
Arachnida	Araneae	Dictynidae	*Unidetified* sp.	0e ± 0
		Dysderidae	*Dysdera crocota*	0e ± 0
		Gnaphosidae	*Micaria dives*	0e ± 0
		Linyphidae	*Sengletus extricates*	8.33d ± 1.53
		Lycosidae	*Wadicosa fidelis*	10d ± 1
			Pardosa sp.	32.33a ± 2.08
		Oecobiidae	*Oecbius* sp.	0e ± 0
		Philodromidae	*Thanatus albini*	0e ± 0
			Philodromus cespitum	0e ± 0
		Pholcidae	*Pholcus* sp.	0e ± 0
		Salticidae	*Thyene imperialis*	0e ± 0
		Thomisidae	*Thomissus spinifer*	0e ± 0
			Auryopis sp.	0e ± 0
		Thridiidae	*Enoplognatha gemina*	0e ± 0
Collembola	Entomobryomorpha	Isotomidae	*Proisotoma minuta*	13.67c ± 1.53
			Pseudanurophorus binoculatus	15.33c ± 3.06
		Entomobryidae	*Pseudosinella octopunctata*	19b ± 1
Diplopoda	Julida	Julidae	*Brachyiulus lusitanus*	0e ± 0
Malacostraca	Isopoda	Agnaridae	*Hemilepistus reaumuri*	0e ± 0
F				231.333*
P				<0.001*

3 replicas for each group Data were expressed using Mean ± SD.

F: F for one-way ANOVA test, pairwise comparison bet. Each of the two groups was done using the post-hoc test (Tukey).

P: p value for comparing between the studied groups *: Statistically significant at $p \leq 0.05$

Means with any common letter (a-e) are not significant (OR means with totally different letters (a-e) are significant).

Conclusion

Quinoa is a perfect plant for combatting the effects of climatic change, especially the rise in temperature degree and salinity, which causes infection with many insect pests. Both public and private organizations have started developing strategic plans that would enable the incorporation and enhancement of plant species that are more tolerant of challenging agricultural and environmental conditions, which would increase the quantity and quality of food to address starvation worldwide and increase food security and safety.

Declarations

Ethics approval and consent to participate: Research on insects was carried out according to the animal protection guidelines approved by the university authorities. All methods were performed in accordance with the relevant guidelines and regulations of the Institutional Animal Care and Use Committee (IACUC), Faculty of Medicine, Alexandria University, and Research Ethics Review Committee at the Faculty of Education, Alexandria University, Alexandria, Egypt.

Consent for publication: Not applicable.

Availability of data and material: The datasets utilized and analyzed during this investigation are available upon reasonable request from the corresponding author.

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Authors' contributions: HA was instrumental in developing the concept and approach for this investigation. AY and HA performed the experiments and gathered the information. The classification of insects and miscellaneous groups was performed via AME, HA, and WZA, the classification of spiders was performed via AY, and statistical analysis was performed via WZA. Writers HA and WZA drafted the manuscript. HA and WZA performed everything from manuscript writing, review, editing, data curation, and visualization. The final manuscript was reviewed and approved by all the authors.

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