



POPULATION DENSITY AND DISTRIBUTION OF INSECT PESTS OF OAK TREE FRUITS IN ERBIL GOVERNORATE

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Abstract

This study was conducted to survey insect pests attacking oak tree fruits (acorns), in six oak tree forest locations belonging to Erbil Governorate-Kurdistan region-Iraq, to estimate infestation percentages, larval number inside acorns and evaluate the effectiveness of insect infestation on the acorn germination ratio during November 2022 to March 2023. The result showed that there were two types of insects belonging to two different orders Coleoptera and Lepidoptera; the Coleopteran insect *Curculio* sp. was more abundant than the Lepidopteran insect *Cydia* sp. For coleopteran larva infestation, Barzan oak tree forests were the most infested location among the studied locations, recording the highest infestation percentage of 40.04% infestation/ sampled acorns and the Choman area was the least abundant in terms of infestation by recording the lowest average 0.88% infestation/ sampled acorns of coleopteran larva infestation. However, for Lepidopteran larva infestation, the highest average percentage of infestation was recorded at 18.25% in Tawska and the lowest average percentage of moth infestation was 2.64% in Choman. In addition, this research indicated that, the weevil larval infestation has the highest impact on the germination rate of acorns by recording 80% failure in acorn germination among tested acorns.

Keywords: Acorn infestation, *Cydia*, *Curculio* sp., Larva, Oak, Weevil.

الكثافة السكانية والتوزيع المكاني للآفات الحشرية لثمار اشجار البلوط في محافظة

اربيل

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الخلاصة

اجريت هذه الدراسة لغرض مسح الآفات التي تهاجم ثمار البلوط في ستة مواقع لغابات اشجار البلوط والتابعة لمحافظة اربيل- اقليم كردستان العراق، وكذلك لتقدير النسبة المئوية للإصابة، اعداد اليرقات داخل الثمار اضافة الى تقييم تأثير الإصابة الحشرية على نسبة إنبات ثمار البلوط خلال الفترة من تشرين الثاني عام 2022 الى شهر آذار 2023. أظهرت النتائج تواجد نوعين من الحشرات التابعة لرتبتي غمدية وحرشفية الأجنحة، كما أن الحشرة *Curculio sp.* التابعة لغمدية الأجنحة هي الأكثر تواجداً من الحشرة *Cydia sp.* التابعة لحرشفية الأجنحة. بالنسبة للإصابات بيرقات غمدية الأجنحة، ظهر بأن أشجار غابات منطقة بارزان هي أكثر الأماكن إصابة من بين جميع المواقع المدروسة، حيث تم تسجيل أعلى نسبة مئوية للإصابة 40.04% لعينات ثمار البلوط، بينما كانت منطقة جومان هي الأقل إصابة بتسجيل أقل معدل للإصابة بيرقات غمدية الأجنحة 0.88%. أما بالنسبة للإصابة بيرقات حرشفية الأجنحة فإن أعلى معدل للنسبة المئوية للإصابة سجلت في منطقة توسكه 18.25% وان أقل نسبة مئوية للإصابة كانت 2.64% في منطقة جومان. إضافة لذلك فان نتائج البحث أكدت بأن يرقات السوسة أظهرت أعلى تأثير في نسبة إنبات ثمار البلوط حيث انخفضت نسبة الإنبات الى 80% من بين جميع الثمار المدروسة.

كلمات مفتاحية: إصابة البلوط، *Cydia sp.*، *Curculio sp.*، اليرقة، البلوط.

Introduction

Oak trees, *Quercus spp.*, are important kinds of forest trees that grow naturally in the mountains area of the Kurdistan region of Iraq (13). Economically, they are among the most useful trees, providing high-quality lumber, firewood, tannins for leather, natural dyes, wildlife habitat; and their acorns are consumed by humans and animals (2); however, germination and natural regeneration acorns are usually to be affected due to their recalcitrant acorns (6 and 17). Research conductors have observed a failure in the natural regeneration of the dominant oak species over the last four decades (11 and 12).

Different factors are responsible for the failure of acorns in their regeneration, research has found that the acorns infested by insects show lower germination than

the non-infested acorns (3), indicating that insects are one of the obstacles to the sexual regeneration of oaks (5 and 18). However, large cotyledon reserves in acorns would act as a potential nutrition pool and aid the seedling to overcome the effect of insect infestation (9).

There are three key insect pests that are widely known in oak acorns, which they are; the acorn moth, the gall wasp, and the acorn weevil. Weevils of the genus *Curculio* are the major culprit (4 and 10) and the most studied group of pests affecting oak regeneration (1 and 14).

Despite damage on one or both cotyledons caused by *Curculio* spp. and other larvae of insects, most insect-infested acorns can still germinate to form a seedling (18). Although cotyledon reserve has been identified as the main resource to improve the early development of the growing plant (8), it remains a big question to what extent cotyledon loss can affect acorn germination. Acorns of some types of oak are frequently infested by weevils, moths and other insect larvae (7).

Field observations indicate that in spite of size, the *Q. variabilis* is usually attacked by a single weevil larva (*Curculio* spp.) in each acorn. *Q. variabilis* acorns are supposed overcome the negative effect of insect infestation on germination easily.

Only a few studies describe their damage to the seedling establishment and ecological adaptability of the world's acorns of *Q. variabilis* (7). However, to our knowledge, no research has been conducted on insect infestations and their damage to oak acorns in Kurdistan- Iraq. Therefore, this study focuses on the investigation of major insects that infest the acorns and estimating their infestation ratio and damage in different locations of Oak tree grown forests in Erbil governorate.

Materials and Methods

Acorn collection and infestation evaluation: The study was performed in different localities of Erbil Governorate (Koye, Darbotk, Tawska, Hanara, Barzan, and Choman) to assess insect infestation and number of larvae in acorn during the period of November 2022 to March 2023. After collection, all oak fruits were transferred to the laboratory and carefully assessed, by removing the pericarp and dissecting the fruits using needles and scissors for observing the presence of insects. The number of larvae in each acorn and feeding site were also recorded for each type of insect larvae.

Acorn germination rate: 90 acorns were collected under the canopy of Oak trees (*Quercus* sp.) in different locations of the oak tree forest area belonging to Erbil governorate during December of 2022 to evaluate the germination ratio of infested acorns in comparison with intact ones. The collected acorns were divided into three groups; the first group was those infested by weevil larvae, the second group was those infested by moth larvae, and the third group was identified as control (intact acorns). Each group included 30 acorns which were divided into three replications each with 10 acorns. Each acorn was placed inside a vial (6 cm height × 3 cm diameter) separately to avoid interaction between groups.

A pot of water was located inside the cage (50 X 60 X 45 cm width, length and height respectively), to provide moisture and facilitate germination of the acorns. In

February 2023, germination rates were recorded by observing the protruding radicle from the hypocotyl.

Identification of Samples: The samples of the insects (Larvae) were collected from infested acorns and sent to the Agricultural Research Center of Erbil- Plant Protection Department –Insects Museum. The insect samples were identified by comparing them with identified samples reserved in the museum and the samples were identified based on molecular techniques.

Statistical Analysis: The obtained data from this study were subjected to the Excel program, and means were worked out to further analytical processes. The means were compared with each other using SPSS Program version 26 (15).

Results and Discussion

Nature and extent of damages of insects infesting acorns: Based on observations and data collected in this research, two types of insects pests were recorded infesting acorns of oak trees in some natural forests of Erbil Governorate, the insects were collected the fallen acorns under oak trees; they were filbert moth (*Cydia* sp.) and Filbert weevil (*Curculio* sp.), which the first belongs to the family of Tortricidae and order Lepidoptera, while the other insect pest was belonged to insect family Curculionidae and order Coleoptera. Looking at damages of *Cydia* sp., the larva after hatching start feeding on the acorns content by boring the pericarp and consuming the external surface of cotyledons creating grooves (open tunnels) on the external side and leaving the larval feces resembling very small balls grouped together in the tunnel (Figure 1 A, B, C) the larva mostly were found individually inside acorns.

Turning to damages caused by larvae of *Curculio* sp., they make holes in the kernel after they were hatched from the eggs and started feeding inside the acorns making feeding tunnels on the cotyledon surface at the small larval instars period; then the larvae grew in size and their necessities in food increased. Therefore, they consume large proportions of the cotyledons and made deep tunnels, and devoured the whole content of the seed in the case of severe infestation. It is worth mentioning that this type of weevil was found in groups of more than two individuals feeding within the acorn, and after period of feeding of numerous larvae, only ashes were left which were mixed with fungi grown due to moisture inside the seed (Figure 2 A, B, C).

The findings of this study are supported by (1 and 5) who recorded the weevils in the genus *Curculio* in their study as a pest on the oak tree, and also the study of (3) found that two insect pests namely *Curculio elaphas* and *Cydia splendana* infested acorns and caused damage by feeding on the cotyledons; the researcher claimed that these insect pests belong to two different families Curculionidae and Tortricidae, the two different orders Coleoptera and Lepidoptera respectively.

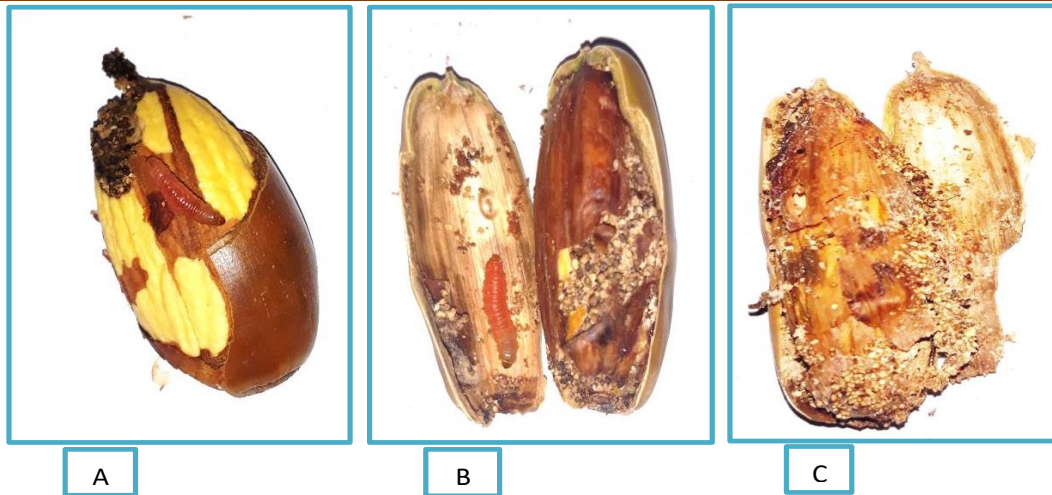


Figure 1 Damages of Filbert moth larva on acorns.



Figure 2 Damages of Filbert weevil larva on acorns.

Effect of location environmental factors on the infestation of Oak tree fruits by insects:

Infestation by Coleopteran insects: The data shown in Table 1 demonstrate information about infestation percentages of Oak tree fruits by Coleopteran weevil larvae in six different locations, Oak tree forests of Erbil governorate- 2022.

Based on data in the Table 1, the highest percentage of infestation by weevil larvae on the Acorns of Oak tree was in Barzan which ranged between 21.05 to 55.31% and averaged 40.04% infestation/ sampled acorns followed by Tawska in which the infestation ratio by weevil larva on acorns was ranged 33.33 to 37.77% and averaged 36.29% acorn infestation/ sampled acorns, while the lowest percentage of infestation was recorded in Choman in which the infestation ratio ranged 0.00 to 1.33% and averaged 0.88% infestation/ Sampled acorns and followed by Koye location, the infestation ranged 7.01 to 9.83% and averaged 8.30% infestation/ sampled acorns. However, the Hanara and Darbotk zones occupied the middle position in terms of infestation ratio which was 11.0 to 19.0 and averaged 17.21% infestations/ sampled acorns for Hanara and the infestation percentage ranged from 18.81 to 29.54% and averaged 22.93% infestation/ sampled acorns in Darbotk.

According to statistical analysis and the Duncan test of 0.5 significant levels, there is a significant difference between some of the studied locations in terms of weevil larva infestation on the acorns. The study of (3) reported that the number of weevils that attacked acorns over three studied sites ranged between 17 to 68% infestation, which means that the infestation ratio differs from site to site and this to some extent supports our results in the current study.

Table 1 Infestation of Oak tree fruits by *Curculio* sp. in different localities of Erbil Province.

| No. | Locations | % Infestation of Acorns by Coleopteran insects | | | Elevations (Height above mean sea level)- Meter |
|-----|-----------|--|---------|---------------------|---|
| | | Minimum | Maximum | Mean \pm SE | |
| 1 | Koya | 7.01 | 9.83 | 8.30 \pm 0.82 cd | 600 |
| 2 | Hanara | 11.00 | 19.00 | 17.21 \pm 3.11 c | 678 |
| 3 | Tawska | 33.33 | 37.77 | 36.29 \pm 1.48 ab | 989 |
| 4 | Choman | 0.00 | 1.33 | 0.88 \pm 0.44 d | 2407 |
| 5 | Barzan | 21.05 | 55.31 | 40.04 \pm 10.0 a | 735 |
| 6 | Darbotk | 18.81 | 29.54 | 22.93 \pm 3.33 bc | 501 |

Different letters in a column are significantly different from each other at the level of 0.05.

Infestation by Lepidopteran insects: The data shown in Table 2 demonstrate information about infestation percentages of Oak tree fruits by Lepidopteran moth larvae in six different locations, Oak tree forests of Erbil governorate in 2022.

Based on data in the table 2, the highest percentage of infestation by moth larvae on the Acorns of Oak tree was in Tawska which ranged between 13.33 to 24.44% and averaged 18.25% infestation/ sampled acorns followed by Koye in which the infestation ratio was ranged from 8.06 to 19.29% and averaged 11.83% infestation/ sampled acorns, while the lowest percentage of infestation was recorded in Choman in which the infestation ratio ranged from 0.00 to 5.33% and averaged 2.64% infestation/ sampled acorns and followed by Darbotk location, the in which the infestation ratio caused by moth larvae ranged between 2.27 to 6.81% and averaged 4.54% infestation/ sampled acorns. However, the Hanara and Barzan zones occupied the middle rank in terms of infestation ratio caused by moth larva which was 0.00 to 16% and averaged 5.70% for Hanara, and in Barzan the infestation percentage due to moth larvae ranged from 5.31 to 7.32% and averaged 6.31% acorn infestation/ sampled acorns.

According to statistical analysis and the Duncan test of 0.05 significant levels, there is a significant difference between Tawska and all other locations, except Koye, regarding the infestation ratio due to moth larvae and both of them have differed significantly from the rest of the studied locations. However, there is no significant difference among four the locations of studied area including Hanara, Choman, Barzan, and Darbotk in terms of infestation percentage caused by moth larvae on Oka tree acorns. The findings of this study mirror those reported by (3) who found that the percentage infestation depends on the location of forest trees.

Table 2 Infestation of Oak tree fruits by *Cydia* sp. in different localities of Erbil Province.

| No. | Locations | % Infestation of Acorns by Lepidopteran insects | | | Elevations (Height above mean sea level)- Meter |
|-----|-----------|---|---------|---------------|---|
| | | maximum | minimum | Mean ± SE | |
| 1 | Koya | 8.06 | 19.29 | 11.83±3.70 ab | 600 |
| 2 | Hanara | 0.00 | 16.00 | 5.70±5.15 b | 678 |
| 3 | Tawska | 13.33 | 24.44 | 18.25±3.26 a | 989 |
| 4 | Choman | 0.00 | 5.33 | 2.64±1.5 b | 2407 |
| 5 | Barzan | 5.31 | 7.32 | 6.31±0.58 b | 735 |
| 6 | Darbotk | 2.27 | 6.81 | 4.54±1.31 b | 501 |

Different letters in a column are significantly different from each other at the level of 0.05.

Intensity of insect larvae within acorns: The data provided in Table 3 and 4, shows the larval number of Coleopteran weevil and Lepidopteran moth in acorns of Oak tree from six different locations, Oak tree forests) of Erbil governorate in 2022.

According to Table 3, the highest average number of weevil larvae was recorded in the oak tree forests of Barzan, which ranged from zero to 9.00 larvae/ acorn and averaged 3.18 larvae/ acorn followed by Tawska oak tree forests in which the larval number was ranged from zero to 6.00 larvae/ acorn and averaged 1.8 larvae/ acorn. Whereas, the lowest weevil larval number was recorded in each of Darbotk, Choman, and Hanara in which average larval number was 0.50, 0.66, and 0.74 larvae/ acorn, respectively. However, Koye occupied the middle rank concerning the larval number by recording an average larval of 1.4 larvae/ acorn.

Based on the statistical analysis and Duncan test, 0.05 significant levels, the data recorded for weevil larval number in Tawska and Barzan did not differ significantly from each other; it is worth mentioning that they both showed significant differences with the data recorded in the rest of studied locations, while the weevil larval number which recorded in each of Darbotk, Choman, Hanara, and Koye were at par with each other. In a field guide, (16) mentioned that the number of weevil larvae per acorn was between one to eight individuals for a single acorn. These results support the findings of the current study.

Turning to moth larval number which is provided in the Table 4, the highest average number of Lepidopteran moth larvae was registered in oak tree forests of Darbotk in which the larval number ranged from 0.00 to 1.00 larvae/ acorn and averaged 0.44 larvae/ infested acorn, followed by Hanara and Barzan in which the average moth larval number were 0.39 larvae/ acorn and 0.37 larvae/ acorn, whereas, the lowest moth larval number was recorded in each of Koye and Choman by recording averages of 0.05 and 0.08 larvae/ acorn, respectively. Nevertheless, Tawska occupied the middle rank in terms of average moth larval number by recording the average larval number of 0.21 larvae/ acorn.

Looking at statistical analysis and the Duncans test, at 0.05 significant levels, there is no significant difference between moth larval numbers in all studied forest locations. It is worth concluding that this insect larva was found singly in most cases and a few

samples of acorns contained two larvae. This finding mirrors those mentioned by (16) who stated that the moth of the genus *Cydia* lays eggs singly on the individual acorns.

Table 3 Number of *Curculio* sp. larvae per Acorn in different locations in Erbil provinces.

| No. | Locations | % Number of Coleopteran larvae/ Acorn | | |
|-----|-----------|---------------------------------------|---------|--------------------|
| | | Minimum | maximum | Mean \pm SE |
| 1 | Koya | 0.00 | 11.00 | 1.4 \pm 0.87 b |
| 2 | Hanara | 0.00 | 8.00 | 0.74 \pm 0.53b |
| 3 | Tawska | 0.00 | 6.00 | 1.81 \pm 0.32 ab |
| 4 | Choman | 0.00 | 1.00 | 0.66 \pm 0.33 b |
| 5 | Barzan | 0.00 | 9.00 | 3.18 \pm 0.14 a |
| 6 | Darbotk | 0.00 | 1.00 | 0.50 \pm 0.02 b |

Different letters in a column are significantly different from each other at the level of 0.05.

Table 4 Number of *Cydia* sp. larvae per Acorn in different locations in Erbil provinces.

| No. | Locations | Number of Lepidopteran larvae/ Acorn | | |
|-----|-----------|--------------------------------------|---------|-------------------|
| | | minimum | maximum | Mean \pm SE |
| 1 | Koya | 0.00 | 1.00 | 0.05 \pm 0.00 a |
| 2 | Hanara | 0.00 | 1.00 | 0.39 \pm 0.33 a |
| 3 | Tawska | 0.00 | 2.00 | 0.21 \pm 0.11 a |
| 4 | Choman | 0.00 | 2.00 | 0.08 \pm 0.08 a |
| 5 | Barzan | 0.00 | 1.00 | 0.37 \pm 0.20 a |
| 6 | Darbotk | 0.00 | 1.00 | 0.44 \pm 0.29 a |

Different letters in a column are significantly different from each other at the level of 0.05.

The Effect of insect infestations on acorn germination rate: The data shown in Table 5 displays the impact of infestation by two types of insects on the oak tree acorn germination in Erbil province, 2022.

According to Table 5, the highest ratio of germination was recorded in acorns infested by Lepidopteran moth larvae among infested acorns which ranged from 70 to 90% germination rate and averaged 80%, which means that an average of 20% of moth infested acorns failed to germinate. However, weevil infested acorns were found to be the most affected by infestation and recorded the lowest germination ratio which ranged from 20 to 30% and averaged a 20.66% germination rate; it means that; the infestation by weevil larvae caused nearly 80% failure in the germination of acorns infested by weevil larvae.

In this study, after the acorns had been placed for germination test, they were checked and realized that some of the infested acorns germinated while others did not show any growth of embryo as in Figure 3.

Depending on the statistical analysis and Duncan test, 0.05 significant levels, weevil infested acorns is significantly different in comparison with both moth larvae infested and intact acorns, while there is no significant difference between moth infested and intact acorns (control), in terms of germination rate based on statistical analysis.

The study revealed that the weevil larvae infestation has a greater effect than moth larvae infestation on the germination of acorns. This indicates that the infestation of acorns by weevils is the most effective and key factor reducing the germination ratio and contributes, effectively; to destroying new seedling establishments. The findings of the current study supported by (7) who found that the weevil larvae were more abundant than the moth larvae and Acorns injured by *Curculio* weevils displayed a significantly lower germination rate since there was large endosperm damage than the rate for sound acorns.

Table 5 Germination ratio of insect infested and non-infested Oak tree acorns in Erbil provinces.

| No. | Factors | Germination ratio % | | |
|-----|------------------------------|---------------------|---------|-------------------|
| | | minimum | maximum | Mean \pm SE |
| 1 | Coleopteran infested acorns | 20.00 | 30.00 | 20.66 \pm 0.33b |
| 2 | Lepidopteran infested acorns | 70.00 | 90.00 | 80.00 \pm 0.57a |
| 3 | Intact acorns | 90.00 | 100.00 | 90.33 \pm 0.33a |

Different letters in a column are significantly different from each other at the level of 0.05.



Figure 3 Germinated and non-germinated infested acorn caused by both insects.

Conclusions: Insects are the most contributing factor to the suppression of agriculture and forests, especially the larval stage which is the harmful stage among some insect order due to possessing chewing mouthparts and feeding on plants effectively. In this research, two types of insects were recorded infesting oak tree fruits. This research indicated that the infestations by both Lepidoptera and Coleopteran insects had an impact on acorn germination; however, the effectiveness of weevil infestation was more than moth infestation, on the germination rate of acorn. We concluded that; it is advisable to find an effective technique to prevent and suppress the insect infestation in oak tree forests which play a vital role in CO₂ recycling.

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