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Economic importance of date palm *Phoenix dactylifera* L. (Liliopsida: Arecales: Arecaceae) pests in Jordan Valley

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Abstract. Field trips were conducted in two date palm farms in Jordan Valley from April, 1999 to December, 2000 and random samples and observations for field status for date palm pests in different regions in Jordan from 2001 to 2014 to show the economic importance for fourteen insect pests. These pests namely are green scale *Asterolecanium phoenicis* Ramachanda Rao, gray date scale *Parlatoria blanchardi* (Targioni Tozzetti), red scale *Phoenicococcus marlatti* Cockerell, Old World date bug *Ommatissus binotatus lybicus* de Bergevin, date thrips *Adiheteothrips jambudvipae* Ramok, great date moth *Arenipses sabella* Hampson, lesser date moth *Batrachedra amydraula* Meyrick, ephestia moth *Ephestia* spp, red palm weevil *Rhynchophorus ferrugineus* Olivier, dried fruits beetle *Carpophilus hemipterus* (L.), pineapple beetle *Urophorus humeralis* Fabricius, rhinoceros borer beetle *Oryctes rhinoceros* (L.), Oriental wasp *Vespa orientalis* Fabricius and vinegar fly *Drosophila melanogaster* (Meigen).

Key words: Date palm tree, Pests, Economic importance, Jordan.

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Introduction

Date palm tree *Phoenix dactylifera* L. is mentioned in the holy Quran and the Bible. It has a special consideration in our hearts as Muslims and Arabs. This tree is an important component of Arab World Flora. Date palm tree is considered one of the fruit trees that belong to Arecaceae. The genus consists of fourteen species distributed in the tropical and sub tropical regions. In Jordan, there are many locations that have old date palm trees, but in the recent years, there is an expansion in its plantation especially in those areas that have environmental conditions, mainly Jordan Valley, Aqaba and Azraq.

The tree productivity fluctuates from year to another due to the pest's status in the field. The productions also fluctuate and differ from location to another. Of these pests which recorded in Aqaba (Mustafa-Al Antary and Sharaf, 1994) were (a) gray date scale *Parlatoria blanchardi* Targioni Tozzetti (Homoptera: Coccidae), (b) almond moth *Ephestia* (*Cadra*) *cautella* Walker (Lepidoptera: Pyralidae), (c) Old World date mite *Oligonychus afrasiaticus* (McGregor) (Acari: Tetranychidae), and (d) fruit stalk borer *Oryctes elegans* Prell.

(Coleoptera: Scarabaeidae). In Addition, greater date moth *Arenipses sabella* Hampson (Lepidoptera: Pyralidae) and lesser date moth *Batrachedra amydraula* Meyrick (Lepidoptera: Cosmopterygidae) have been observed attacking date palm in Jordan Valley (Al Antary et al., 2015).

In spite of the economic importance of some insect pests of date palm, which threatening the tree plantation and expansion in Jordan, there is only one published report (Mustafa-Al Antary and Sharaf, 1994) about recording some insects attacking palm in Aqaba (Al Antary et al., 2015). However, few studies have been conducted yet on the number of pests, number of generation, and the distribution in different localities in Jordan (Al Antary et al., 2014; Al Antary and Al-Khawaldeh, 2014; Al Antary et al., 2015). During conducting the research Mustafa-Al Antary and Salamah (1999) recorded the destructive red (Indian) palm weevil *Rhynchophorus ferrugineus* F. in Jordan, which considered as a key in many countries. However, four pests were observed in the field. These were greater date moth *Arenipses sabella*, lesser date moth *Batrachedra amydraula*, Old World date mite *Oligonychus afrasiaticus* in Aqaba and grey date scale *Parlatoria blanchardi*. The first two attack the floral parts; the later attacks the fruits in the pre- and post-harvest phase. As a result, the production significantly decreases annually.

A survey of the arthropods overwintering on date palm in the middle of Iraq was conducted in the winter season 1989-1990; eight insects were recorded to overwinter in palm trees (Al-Khafaji and Abdul-Hab, 1993). In a survey of date palm insect pest in Libya done by Bitaw and Ben-Saad (1990), 12 species of insects were recorded to infest date palm trees; five of which were recorded for the first time. Murlidharan (1993) conducted a survey of scale insects of date palms and their natural enemies in the date grooves of Kachchh (India). He recorded six predators and one parasitoid to attack two species of scale insects. A study of date palm borers and their management were conducted in Pakistan in 1990 (Naeem et al., 1992). The distribution of red palm weevil in the Arab countries includes Egypt, Saudi Arabia, United Arab Emirates (UAE), and introduced to Qatar from Saudi Arabia in 1989 (Al-Khunji and Al-Turaihi, 2000). Elmer (1966) studied the following major pests of USA: *Oligonychus pratensis*, *Carpophilus dimidiatus* L., *Carpophilus hemipterus* (L.), *Haptoncus luteolus* (Erichson), and *Urophorus humeralis* (Fabricius). Strumpel (1969) studied the pest of date palm in North Africa, recording three species of mite and five species of insects.

Date fruit moth *Ephestia* (*Cadra*) *cautella* Walker was recorded in Egypt, Iraq, Saudi Arabia, Morocco, Libya, Algeria and Jordan (Badawi et al., 1979; El-Haidari and Al-Hafidh, 1986; Abdul Salam, 1993; Mustafa-Al Antary and Sharaf, 1994). Swayir et al. (1982) made an investigation on plant fruit borer *Oryctes elegans* Prell. in Iraq. The investigation showed that the pest had one generation a year. Adults caused damage to alive tissues of fruit bunch, while larvae fed on decade plant materials. El Haidari et al. (1981) published a table in which the economic importance and distribution of the important date and palm insects in the near East and North Africa were reported.

The study objectives were to investigate the pest status and its economic importance on date palm in different regions of Jordan. These studies could be helpful in controlling these pests with the proper agricultural practices and other means of integrated pest management to avoid pesticide resistance and residues, and to minimize environmental contamination with the intensive use of insecticides.

Materials and methods

Field Work

a) Collecting sites. Collecting sites were Al-Baqurah (125 km), Deir-Alla (50 km), Wadi Fannush (50 km), Ghor Kabid (50 km), Karameh (70 km) South Shuna (70 km) and Aqaba (330 km) from Amman, the capital. However, random samples and observations were carried out in different regions of Jordan between 2001 up to 2014 to show the pest status and economic importance of the served insects on date palm. The survey mainly concentrated on

Jordan Valley main date palm groves. Some materials were also collected from Aqaba.

b) Collecting methods. In each collecting site, once every one month for two years (1999-2000), date palm trees were examined for any mite or insect infestation. Random samples were collected by the following methods:

The base of the stem, stem trunk, leaves, bunches and the top of the trees were checked for any pest infestation. Insects found were collection and killed by using killing jar. Soft body-small insects were preserved in 70% alcohol. Some infested parts of the trees were brought to the laboratory for more examination.

Six light traps (20 W Bio-lab design-USA, manufactured in Jordan were used. Three light traps were placed in each of the two farms (Ghor Kabid Farm and Al-Baqura Farm). The distance between each two traps was more than 50 m and about one kilometer from the electricity source. The trap consisted of a plastic body were arranged as Y shape placed on the funnel. Light neon was placed on a specific place in the plastic sheets. Galvanized steel cap cover the top of the trap. These traps were used to capture moths and other insects. The killing agent was potassium cyanide with the rate of a teaspoon (about 5 g)/killing jar/week covered with few amount of dry wood and jepsom. Insects collected were weekly examined in the laboratory, sorted out and identified. The insect collection extended for two years between April, 1999 to November, 2000.

The farmers or governmental staff from Ministry of Agriculture collected sometimes insects. These materials were considered as part of the survey, collector name was written in each sample.

c) Labeling. Collected samples were labeled with the following data: the name of the locality, date of collecting, part of the tree in which the material collected and other field notes.

Specimens preparation

a) Sorting. Adults of each collected arthropod were stored preliminary into different morphs that were suspected to be a different species.

b Preservation and pinning. Some of the specimens were permanently preserved in 70% alcohol. Other specimens pinned or prepared on slides when needed especially for mite materials.

c) Locations. Two locations were chosen to conduct this investigation for about two years. These were: Al-Baqura Agricultural Station (Al-Baqura Farm) and Ghor Kabid Farm in Kabid Valley. These farms were visited regularly at 1-2 weeks interval from April, 1999 to December, 2000.

Ghor Kabid Farm. The area of this farm is 45 ha (450 dunums), established in 1982, located in Ghor Kabid area, about 10 km to the south of Arida Triangle and 10 km north Shuna. There were about 100 date palm trees, 3 ha (30 dunums) of grab, 0.8 ha (8 dunums) and the rest of the area was planted with vegetables. Date palm trees irrigated by plastic pipes, no pesticides usage and the cultivars grown in this farm were: 300 trees, 18 year old of Dejlat Noor cultivar brought from Tunisia. 30 trees, 3.5 year old of Barhe cultivar brought from Iraq. 50 trees of Ghars cultivar brought from Algeria planted on the street sides. 23 trees of Maktoom cultivar brought from Saudi Arabia planted on the street sides. 100 trees of Zagloli cultivar brought from Egypt and 250 trees, 2.5 year old of Midgold (or Maghool) brought from USA.

Al-Baqura Farm. This farm located in the north Shuna agricultural directorate, about 1 km from the center of the north Shuna to the north. The cultivars grown in this place were: 2.7 ha (27 dunums) of grab and the rest of the area was planted with some citrus and vegetables. Date palm trees irrigated by flooding, no pesticides usage and the cultivars grown in this farm were: Talal Red, Helwah, Dejlat Noor, Dejlat Musa, Khalkhe, Barhe, Kharib, Zainab, Faqer, Khestawi and Yabasi. Those trees were brought from several countries.

f) Meteorological data. Temperature and relative humidity data were obtained from the two meteorological stations; Northern Shuna Station (300 m away from the field in Al-Baqura) and Deir Alla Station (located 15 km from Ghor Kabid Farm).

Results

***Asterolecanium phoenicis* Ramachanda Rao (Homoptera: Asterolecanidae)**

Common name: green scale.

Infesting stage: adult and crawlers.

Plant part and nature of infestation: it was observed that it did suck the sap from the leaflet, midrib and bunches, infested places became discoloured, turning yellowish green. This scale was found mainly on the midrib of the leaves and to smaller extent on leaves specially the upper side.

Distribution and pest status: it was noticed in all visited fields in Jordan Valley between 1999 and 2014 but with unconsiderable damage.

***Parlatoria blanchardi* Targioni Tozzetti (Homoptera: Diaspididae)**

Common name: Gray date scale.

Infesting stage: Adult and crawlers.

Plant part and nature of infestation: it was observed that it did suck the sap from the leaflet, midrib and the dates, under the scale, a discolored area was observed on leaflet, turned yellowish then darker as a sign of dryness. Heavy infestation caused the frond to prematurely drying. This scale was found mainly on the leaflet specially the basal part (Plate 1).

Distribution and pest status: It was noticed in all fields in Jordan Valley and Aqaba between 1999 and 2014.

***Phoenicococcus marlatti* Cockerell (Homoptera: Diapididae)**

Common name: Red scale

Infesting stage: adult and crawlers.

Plant part and nature of infestation: it was observed that it did suck the sap from the green frond bases leaving grey to brown spots. It was mainly found at the fronds that cover with the fiber material of the tree (Plate 2).

Distribution and pest status: it was found in all visited Jordan Valley orchards between 1999 to 2014. It could be considered a secondary pest.

***Ommatissus binotatus lybicus* de Bergevin (Hemiptera: Tropiduchidae)**

Common name: Old World date bug.

Infesting stage: adult and nymph (observed in Iraq, Abu Ghoriab area).

Plant part and nature of infestation: it was observed that it did suck the sap from the leaflets, midrib of the frond and the fruit stalk. The part attacked exuded sap from the punctures made by the insect mouthpart. The insects excreted honeydew.

Distribution and pest status: only three adults were found during the survey, collected from Dair Allah area. Dr. Ali Al Bahadeli of University of Bagdad informed that there was nymphal attack to one tree in Ghor Kabid in Jordan. The symptoms which contained dark spots resulted from the sap and the honeydew were seen but burned directly as a precaution of eggs if there any. Pesticide was applied directly and no nymph was found inspit of the weekly inspection in the area. In addition, samples were collected from Deir Allah, Ghor Kabid and Aqaba between 1999 and 2014, particularly in May, 2013.

Plate 1. Grey date scale: symptoms on leaves, red scale. Source: Al-Khawaldeh (2000).

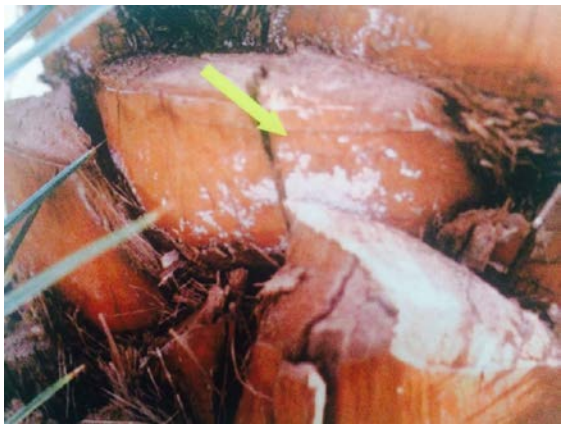

Plate 2. Grey date scale: symptoms on leaves on the fronds base. Source: Al-Khawaldeh (2000).

Adiheteothrips jambudvipae **Ramok (Thysanopetra: Thripidae)**

Common names: Date thrips, Taleh thrips.

Infesting stage: Nymph and adult.

Plant part and nature of infestation: it was observed that it did suck the sap from al taleh (date palm flower) in addition to the symptoms of the egg lying inside the tissue. This insect always existed in the pollen grains and pollination is the key factor for spreading the insect from males to females. Pollen grains exported from Iraq and those collected from males in different areas in Jordan Valley contain this insect.

Distribution and pest status: Jordan Valley and Aqaba and mostly all the date palm growing areas in Jordan. Several specimens were collected from Jordan Valley regions and Aqaba between 1999 and 2014, particularly in March from pollens.

Arenipses sabella **Hampson (Lepidoptera: Pyralidae)**

Common name: Great date moth.

Infesting stage: Larvae.

Plant part and nature of infestation: it was observed that the larvae caused various types of damage. It attacked the fronds, spetha, branches, and newly recorded on attacking stem, dry fruits and the head of seedlings (Plate 3). After the spetha opening the larvae fed on the inflorescence or bored into the base of the fruit stalk, making a cylindrical dark mine as many of 27 small larvae were found. It did bore sometimes into the fruit stalk in Ghor Kabid Farm. Bunches so as Chemri were observed attacked. The fruit stand at the point of arising were observed, which could be recognized by what could be called as a silken wed, in which the larvae hide. Bores in the base of young fronds was seen fatal. Puparium was noticed in high numbers on the stem and on the base of the old un-cleaned fronds. In Fannoush Area in Jordan Valley, the larvae seen to attack the stem itself, the stem was found attacking by other pest (*Urophorus humeralis* (Fabricius)). The two pests were recorded for the first time attacking this part of the plant.

Larvae were recorded attacking the head of new seedling in Ghor Kabid Farm. This was also a new record for the pest attacking this part of the plant. The case was disaster. The seedlings were dead. Dry fruits were attacked by the larvae; all the fruit content were attacked including the hard seed, and the outside (thin layer) was the only part not eaten.

Distribution and pest status: Jordan Valley and Aqaba, 100% of trees were infested in Ghor Kabid Farm and Al Baqurah Farm. 45% and 55% of the bunches were found infested at the harvesting time. Recorded infestation was relied on symptoms. Infestations were observed in February to August particularly in April from 1999 to 2014.

Batrachedra amydraula **Meyrick (Lepidoptera: Momphidae)**

Common name: Lesser date moth.

Infesting stage: Larvae.

Plant part and nature of infestation: it was observed in the visited fields that the larvae attack Chemri, Khalal and early Rutab stages. Larvae entered the fruit at base of the fruit (Plate 4) near the perianth (cap) or through it. Larvae fed on the placenta mainly and on fruit flesh. Seeds in Chemri were attacked but not in later stages, larvae at the Chemri stage connected the attacked fruits by white threads with the source, so the fruit remained hanged. The fruit colour became reddish then dried and fell down. Later stages were not seen, became reddish in colour or dried after infestation but fell down. The fruit infestation percent was 11% in Al Baqurah Farm, 19% in Ghor Kabid Farm during the 2000 season. Samples examined were collected from June to August, 2000 in Jordan Valley and Aqaba, and in July, 2012 in Al Baqurah Farm.

***Ephestia* spp (Lepidoptera: Pyralidae)**

Common name: Ephestia moth.

Infesting stage: Larvae.

Plant part and nature of infestation: this is a stored product insect. Date is a new-recorded host in Jordan. It was observed that Tamur fruits were infested in the field (Deglat Noor), during September and early October in 2000. Few numbers of larvae were found to start infestation, which would continue in the storage.

Distribution and pest status: adults were found in the light traps in both fields. Very few numbers of larvae were found in fallen fruits and harvested fruits.

***Rhynchophorus ferrugineus* Olivier (Coleoptera: Curcullionidae)**

Common name: Red palm weevil.

Infesting stage: Larvae.

Plant part and nature of infestation: it was observed that date trunk (stem) attacked by the larvae, creating cavities full of wet fibers, followed by brownish ooze with bad smell because of decaying and the secretion of the larvae (red secretion). All stages of the pest could be seen inside the trunk. The last instar larvae of these weevils moved to the rind of the stem to prepare a cocoon from coarse fibers and become a prepupa, pupa (Plate 5) and then adult. The plant might appear healthy but infested and then died suddenly. This was because of the remaining of the old frond bases on the tree. Removal or cleaning the trunk of old dry fronds bases was important to check infestation. Adult female weevils were attracted to pruning or chain saw wounds, stressed, or healthy palms. Larvae bored into the palms and after several instars develop into adults within several weeks. It has one generation per year in Jordan. The generation extends from June to September with a peak in August.

Physiphora sp. was noticed associated with infestation of red palm weevil, mainly with high numbers of larvae. It might be considered as an indicator for borer attack. It fed on decayed materials.

Distribution and pest status: Middle Jordan Valley to the south (Ghor Kabid mainly). First record was during May, 2000. Due to the use of several practices to control this destructive pest is being under control up to 2014, but it has been appearing from time to time in summer month of every year from 1999 to 2014.

***Carpophilus hemipterus* (L.) (Coleoptera: Nitidulidae)**

Common name: Dried fruits beetle.

Infested stage: Larvae.

Plant part and nature of infestation: It was observed that these pests were a stored product insect. Kalal and Tamur were infested in the field during September and early October in 2000 season, especially of fermented dates on the plants or on the ground. Fermentation might be caused as a result of a disease, wetness or bad agriculture practices as bunching backing which might play as a source of infestation. Larvae fed on the fruit flesh making considerable losses in the product and then this product was badly marketed.

Distribution and pest status: Jordan Valley, late producing date trees as Deglat Noor cultivar. It was a key pest that needed monitoring before making big losses *Carpophilus hemidiatus* (corn sap

Plate 3. Great date moth: symptoms on seedling. Source: Al-Khawaldeh (2000).

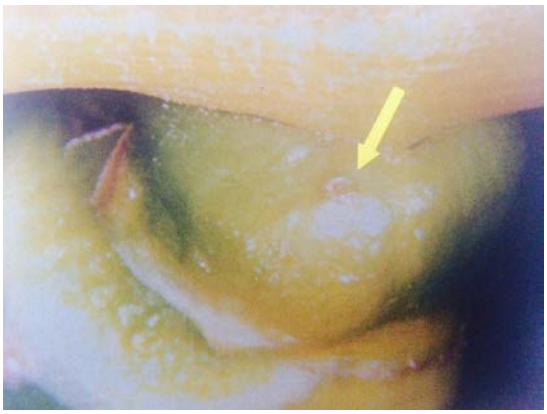

Plate 4. Lesser date moth: larval entrance at the base of infested fruit. Source: Al-Khawaldeh (2000).

Plate 5. Red palm weevil: puparium and pupa. Source: Al-Khawaldeh (2000).

Plate 6. Fruit stalk borer: larva. Source: Al-Khawaldeh (2000).

beetle). The later was with few numbers. It was very common on dried fruits of date palm in Iraq.

Urophorus humeralis **Fabricius (Coleoptera: Nitidulidae)**

Common name: Pineapple beetle.

Infested stage: Larvae and adult

Plant part and nature of infestation: It was observed in the visited fields in Jordan as in the case of *Carpophilus* spp. In addition, this species was found attacking the trunk associated with the great date moth. It might be attracted by the decay matter that was caused by a disease or a borer. The insect bored inside the trunk. This was a new record resulted into the bending head of the infested tree.

Distribution and pest status: Jordan Valley as a stored product insect. It was observed only in three trees, one in South Shuna and other two in Ghor Kabid in September, 2000. The new feeding behavior was recorded.

Oryctes rhinoceros **(L.) (Coleoptera: Scarabidae)**

Common name: Rhinoceros borer beetle

Infesting stage: Larvae and adult.

Plant part and nature of infestation: It was observed that the adult made a surface mine in the midrib of fruit stalk; the mine was dark in colour. The dates in the unattacked side did not die but became smaller in size. When the mine was covered the majority of the stalk cross section, the fruit stalk was dried and died and then no production. Larvae (Plate 6) were found in the root system causing a hole leading to death of the small plant (one year old).

Distribution and pest status: It was a key pest in Aqaba (date palm farm). Several larvae were collected from the date palm farm in Aqaba in April and May in 1999. The *Oryctes elegans* Prell. and *Oryctes boas* (Fabricius) were also recorded in Jordan in Aqaba in May 26, 2000.

***Vespa orientalis* Fabricius (Hymenoptera: Vespidae)**

Common name: Oriental wasp.

Infesting stage: Adult.

Plant part and nature of infestation: It was observed that the wasp fed on matured dates. Chemri and Khalal were only attacked. It fed on small bits of the fruit surface on the plant or during harvest on the ground, increasing the possibility of secondary disease infection, lowering the marketable value of the product and then indirect effect by annoying the workers.

Distribution and pest status: Jordan, potential pest. It is very common in different parts of Jordan in summer months.

***Drosophila melanogaster* (Meigen) (Diptera: Drosophilidae)**

Common name: Vinegar fly.

Infesting stage: Larvae and adult.

Plant part and nature of infestation: It was observed that larvae fed on fermented dates. It was a stored product insect. Adults contaminated the dates in the fields, laid the eggs on fruits in the field and the larvae appeared in the store, lowering the marketable value of dates, in addition to the direct loss made by larvae consumption of the dates.

Distribution and pest status: Jordan, secondary pest in the field, potential pest in the stores. It does occur commonly in August and September every year.

Discussion

The actual number of species that occurred in Jordan can be closely estimated only by conducting a survey for long time, collecting materials from all date palm planted areas in Jordan. Also it should be taken in consideration that new species might be introduced into the country with the introduction of plant materials from any area that could be infested with pests, as the case of some pest, namely the red palm weevil *Rhynchophorus ferrugineus* Olivier.

Three insect pest species and one mite species were recorded from Jordan. Mustafa-Al Antary and Sharaf (1994) recorded three insect species and one mite from Aqaba area, namely *Parlatoria blabchardi* Targioni-Tozetti (gray date scale), *Oryctes elegans* Prell. (fruit stalk borer), *Ephestia* (*Cadra*) *cautella* Walker (almond moth) and *Oligonychus* (*Paratetranychus*) *afrasiticus* (McGregor) (Old World date mite).

Red (Indian) palm weevil *Rhynchophorus ferrugineus* Olivier was added to date palm fauna of Jordan as an introduced pest (Mustafa-Al Antary and Salameh 1999; Mustafa-Al Antary et al., 2000), to increase the recorded species to five. These species were also collected during this study. However, *Oryctes rhinoceros* (L.) (rhinoceros borer beetle) was misrecorded as *Oryctes elegans* Prell. (fruit stalk borer). This was found after the examination of materials collected at that time, compared with key specimens of *Oryctes elegans* brought from Baghdad and following illustrated keys published by Lepsume (1947). The late identification was confirmed by Abdul Al-Rassoul of Baghdad Insect Museum.

Three other insect pest species and one mite species were newly recorded during this study on date palm, namely *Vespa orientalis* Fabricius (Oriental wasp) and *Drosophila melanogaster* (vinegar fly) on the fruits. *Blattella germanica* L. (German cockroach) on the trunk. The mite species was *Tetranychus urticae* (two spotted red mite) on the leaves. These

raised the pests number attacking date palm to eight species.

Eleven insects species and one mite species were newly recorded attacking date palm trees, namely *Asterolecanium phoenicis* Ramachanda Rao (green scale), *Phoenicococcus marlatii* Cockerell (red date scale), *Ommatissus binotatus lybicus* de Bergevin (Old World date bug), *Adiheteothrips jambudvipae* Ramok (date thrips), *Batrachedra amydraula* Meyrick (lesser date moth), *Arenipses sabella* Hampson (great date moth), *Oryctes rhinoceros* L. (rhinoceros borer beetle), *Carpophilus dimidiatus* F. (corn sap beetle), *Carpophilus hemipterus* (L.) (dried fruit beetle), *Carpophilus mutilates* (Erichson) (confused sap beetle), *Urophorus humeralis* Fabricius (pineapple beetle) and the mite species was *Eutetranychus banksi* (Texas citrus mite). These newly recorded species raised the number of species attacking date palm trees (in addition to some stored product insects collected from the field) in Jordan to be twenty species. In addition, one termite species and other *Ephestia* species which needs specific identification.

Twenty-two insect species were recorded to attack date palm in the field in the Near East and North Africa (Dowson, 1921; Lepsume, 1947; Hussain, 1963; Avidov and Harpaz, 1969; Eaa, 1973; Hussain, 1974; Al-Ali, 1980; Endroli, 1980; El-Haidari, 1981; El-Haidari et al., 1981; El-Haidari and Hafidah, 1986; Bitaw and Ben Saad, 1990; Abdul Salam, 1993; Al-Khunji and Turaihi, 2000; Murphy and Briscoe, 1999). From these, eleven species were recorded in Jordan. Another two pests, namely *Viricola livia* Klug. and *Schistocerca gregaria* Forsskål (El-Haidari and Al-Hafidh, 1986) were found in Jordan but not recorded to attack date palm during this study.

Sixteen species were recorded in Iraq, 15 in Egypt, 14 in Saudi Arabia (El-Haidari and Al-Hafidah, 1986), 9 in Libya (Bitaw and Ben Saad, 1990), and 8 in Palestine (Avidov and Harpaz, 1969; El-Haidari and Al-Hafidah, 1986). However, in Jordan, Mashal and Abiedat (2006) surveyed 36 insect pests on date palm trees; red palm weevil (RPW), greater date palm moths (GDM), lesser date palm moths (LDM) and frond palm borer (FPB) were found to be the most destructive pests to date palm trees in Jordan. These pests caused an important loss in the fields. Dust mite, also detected as an economic pest caused high loss, especially in dusty places. Other recorded moths, weevils, mites and flies were found in the fields under various intensities.

In Saudi Arabia, El-Shafie (2012) reported that ten species are considered as major pests viz., the red palm weevil *Rhynchophorous ferrugineus*, Old World date mite *Oligonychus afrasiaticus*, lesser date moth *Batrachedra amydraula*, dubas date bug *Ommatissus binotatus*, green pit scale *Palmapsis phoenicis*, carob moth *Ectomyelois ceratoniae*, longhorn date palm stem borer *Jebusaea hammerschmidti*, rhinoceros beetle *Oryctes agamemnon*, fruit stalk borer *Oryctes elegans* and almond moth *Ephestia* (*Cadra*) *cautella*. In addition, El-Juhany (2010) stated that 30% of production can potentially be lost as a result of pests and disease. In the Gulf Countries and Egypt, the red palm weevil has recently become one of the major date palm pests, while bayoud disease caused by a parasitic fungus is a common threat to date palms in North Africa.

The economic importance of the recorded species differs from one to another; consequently the discussing of the recorded species will be depending on the degree of their importance. Red palm weevil was considered as the most destructive pest of date palm tree in Jordan. This result agreed with the findings of the same pest, in Palestine, in Egypt and Saudi Arabia (Abdul Jawad, 1996) and in the other Gulf countries (Murphy and Briscoe, 1999). This insect was considered as one of the examples of the introduction of a pest, which needs a regional cooperation to find way to control it and stop its spread. In Jordan, Ministry of Agriculture, the University of Jordan and Jordan Valley authority worked on stopping the spread of this by different kinds of controlling measures. This pest could destroy the tree and not easy to be controlled because of the nature of injury.

Great date moth was considered to be one of the most economically important pests in Jordan, all trees found infested in Ghor Kabid and Al-Baqurah Farms, 45%

and 55% of the bunches were found infested. Hussain (1974) found 70% of the trees were infested and 49% of bunches were infested in Basra in Iraq. The consideration of this pest as a major pest did not agree with some workers (Hussain, 1974; Kamel et al., 1977; El-Haidari and Al-Hafidah, 1986) whom considered it not as that important. These results agreed with FAO (1974). They reported an outbreak and new record of this pest in India. The present results agreed with Bitaw and Ben Saad (1990) findings. They found that the insect occurred in all grooves visited in Libya.

Lesser date moth was considered one of the main economically important pests in Jordan. 11% and 19% of fruits in Ghor Kabid and Al-Baqurah Farms were found to be infested. This means that 11% and 19% of the production were lost by this pest. Hussain (1974) found that the infestation in southern part of Iraq was between 69-100%. 250,000 trees were found infested in Al-Madina-Basra, Iraq. This pest recorded as a main pest in Palestine (Blumnerg, 1975), Bahrain (Abdul-Jabbar et al., 1982), and other countries in the Near East and North Africa (El-Haidari, 1981).

Grey date scale was observed in all visited fields in Jordan. It was considered one of the main economically important pests in Jordan. This agreed with Mustafa Al-Antary and Sharaf (1994). They reported that this infestation weakened the vegetative growth. Also, it was the major scale insect of the three recorded scale insects attacking date palm not only in Jordan but in the whole region. These results agree with Kehat (1968) findings. He considered this pest as the main pest attacking date palm in Palestine (before the introduction of red palm weevil).

For the other two scales: green and red scale, green scale was observed in all visited orchards, attacking leaves and bunches. This result agreed with several authors (Avidov and Harpaz, 1969; Hissain, 1974; El-Haidari and Al-Hafidah, 1986). They added that it also attacked fruits. It was not a serious pest in the field, although it might be treated as a potential pest that needs monitoring during the season. This result did not agree with El-Haidari and Al-Hafidah (1986). They stated that this insect had no economic importance, but agreed with Avidov and Harpaz (1969) findings in Palestine. Red scale became in the third place when discussing the economic importance, it was found to attack the frond base. Avidov and Harpaz (1969) mentioned, that with the extensive planting of date palm in Jordan Valley and with the introduction of high quality cultivars, the danger posed by this insect also raised since it was liable to retard development of young trees.

Old World date mite was found with very few numbers on one newly imported tree in Dier Alla. In addition, Al-Bahadeli of University of Baghdad (personal communication) noticed nymphal attack on one tree in Ghor Kabid in Jordan. In each location, the control measures were used. No other infestation or materials were collected or seen after that time. This pest was one of the major pests in Iraq (Hussain, 1994), so monitoring program must be established to stand on the real situation in the field. In addition, good quarantine activities must be done for any date palm trees imported from abroad.

Rhinoceros borer beetle was recorded from materials previously collected from Aqaba. Adults attacked fruit stalk (Mustafa Al-Antary and Sharaf, 1994). In addition, El-Haidari and Al-Hafidah (1986) mentioned that its adults borrow the base of upper leaves toward the tree head causing the death of the tree. It was considered as a main pest in India and Qatar (Al-Khunji and Al-Turaihi, 2000). In Aqaba, it was reported by Mustafa Al-Antary and Sharaf (1994) attacking new planted seedlings causing death and burrowed inside the leaves main vein. The same symptoms were seen in Jordan Valley, although the insects were not found. *Pentodon* sp. was collected with high numbers by the light traps in both orchards.

Four Nitulid beetle (*Carpophilus* spp) were found attacking the fruits in the field. Pineapple beetle adult and larvae attacked the fruits on the plant. This agreed with the findings of several authors (Kehat et al., 1976; El-Haidari and Al-Hafidah, 1986) who found that the adult and larvae attacked the fruit in Tarablose in Libya. El-Haidari et al. (1981) found the insect attacking the fruits on the trees treated with

growth regulators. This pest was observed attacking the stem of the tree, the association with great date moth causing considerable damage to the stem, this part of plants was newly recorded to be attacked of these two pests.

Dried fruit beetle was the most abundant Nitulid beetle attacking the fruits at the maturation stage and after harvesting, always associated with fungal infestation. Following by corn sap beetle then mutilates beetle was with very few numbers. Dried fruit beetle was considered the main post harvest insect pest found in the field. This agreed with Saleh (1983) who found that this insect was an important pest of fresh and dry fruits in Iraq. In addition, it was responsible for several fungal diseases on several fruits worldwide. Also, these results agreed with El-Haidari and Al-Hafidah (1986) findings, who found that dried fruit beetle density was the highest among six stored product insects monitored in the field in Baghdad, Iraq. Avidov and Harpaz (1969) found that dried fruit beetle was the most common insect in Palestine followed by the corn sap beetle. They added that dried fruit beetle attacked all kinds of fruits as a secondary pest. Attacking usually occurs after a previously injured fruits, but the presence of this beetle on dates is an exception to the rule. These insects appear on ripening dates, gnaw at fruits and laid eggs. The larva develops rapidly, because of the high temperature prevailing at summer.

Oriental wasp was observed attacking fruits in late stages especially late cultivars. The wasp ate small bits of the fruit surface decreasing the marketing value of the product. These results agreed with several authors (Avidov and Harpaz, 1969; El-Haidari and Al-Hafidah, 1986). They found that this pest attacked fruits on the trees, in addition to, those falling on the ground specially semi dried and wet fruits in the late of the season.

Ephestia moth was found in very low numbers in the field and in the product gathered after harvesting. This was considered as a main stored date pests in the surrounding countries (Hussain, 1974; El-Haidari and Al-Hafidah, 1986). Date thrips was found in all pollen grains collected from trees or imported from Iraq (Al-Barakah Farm, South Shuna in Jordan). It might be considered with no economic importance.

Conclusions and recommendations

Conclusions

From the present results, the following points could be concluded:

1. Jordan located in the middle of the countries which had the most date palm trees numbers in the world. This might explain why there were relatively high numbers recorded attacking date palm (20 species). The possibility of the introduction of new pest from other area is highly expected.

2. Red palm weevil *Rhynchophorus ferrugineus* Olivier was considered the main key pest due to the fatal effect of its attack. Also, it could be considered as an example of an introduction of a destructive pest.

3. Great date moth *Arenipses sabella* Hampson was considered as one of the key pests due to the high infestation rates, that might exceed 100% of trees and 55% of bunches during the season. It was observed to infest fronds, sheathe and date bunches. For the first time infestation was also observed in the stem and new seedlings leading of death of these seedlings. Light traps were good method for collecting the adults during the season.

4. Lesser date moth *Batrachedra amydraula* Meyrick was considered as one of the key pests due to the high losses during the season that might exceed 19% of the fruits drying.

5. Grey date scale *Parlatoria blanchardi* Targioni Tozzetti was the main scale pest attacking date palm in Jordan.

6. Rhinoceros beetle borer *Oryctes rhinoceros* (L.) was observed as a serious pest in Aqaba. Precautions must be made in order to avoid its spreading to other areas in Jordan.

7. Dubas date bug *Ommatissus binotatus* Fieber was recorded on imported plants in a very low numbers. Awareness must be made to control any appearance to this epidemic pest.

8. Dried fruit beetle *Carpophilus hemipterus* (L.) was the most abundant

stored product pest in the field. It was noticed attacking the fruits in late stages on the trees monitoring must be made in order to take control measures to decrease its population so as the oriental wasp which increased the possibility of stored product infestation due to the small entrance into the fruits that the wasp made through its small bites made.

Recommendations

The following suggestions are recommended to help in minimizing the damage occurred to date palm trees in Jordan.

1. Using the study results to activate quarantine measures concerning date palm in boarders and between different areas in Jordan.
2. Removing the old leaf base on the trunk (cleaning).
3. Light traps could be used in monitoring the first appearance of great date moth.
4. Many of the insects overwintered inside the tree head. Control measures could be used as oils.
5. Minimizing the insect pest population by using control measures is recommended for the first generation of great date moth and lesser date moth, which might be started in March/April.
6. Date palm pests need more ecological studies.
7. Biological control studies should be encouraged.

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Conflict of interest statement

Authors declare that they have no conflict of interests.

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