

Distribution and Host Range of the African Fig Fly *Zaprionus indianus* (Diptera: Drosophilidae) in Jordan

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ABSTRACT

The African fig fly, *Zaprionus indianus* (Diptera: Drosophilidae) was recorded for the first time as a pest on date palms (var. Madjuol) in the Central Jordan Valley in June, 2012. Field trips were conducted to different orchards of fruit trees during the period from February to August, 2013 in the Jordan Valley, the high lands and the desert. Flies observed flying over decomposing or rotting fruits dropped on the ground were sampled by sweeping net. Fallen fruits were collected and incubated in the laboratory until adult flies emergence. Banana baited traps seeded with dry and active yeast *Saccharomyces cerevisiae* were placed in several commercial fruit orchards. Our survey showed that *Z. indianus* was found in different ecosystems with variable abundance on many host plants in Jordan, utilizing diverse food resources. The fly was found on many fruits such as mulberry, grapes, peach, nectarine, plum, figs, date palm, sweet orange, sour orange, blackthorn, pomegranate, guava and apple. The minimum percentage of emerged adults of *Z. indianus* was 9.0%, which was recorded from fruits collected from Northern Jordan Valley during February, while the maximum percentage was 99.1% obtained from fig fruits collected from Southern Jordan Valley during June. The minimum percentage of adult *Z. indianus* in banana-baited traps was 49.7%, which was collected from peach orchard in June from Al Salt, while the maximum percentage was 93.9% on date palms in Dayr Alla in July. Our results provided basic and essential data needed for implementation of control measures against the fly population.

Keywords: *Zaprionus indianus*, African fig fly, host plant spectrum, geographic distribution, figs, Jordan.

INTRODUCTION

The African fig fly, *Zaprionus indianus* Gupta (Diptera: Drosophilidae) is a semi-cosmopolitan fly

which has spread across tropical regions in recent decades (van der Linde *et al.*, 2006). It is an invasive species which successfully colonized the Indian subcontinent more than four decades ago (Yassin *et al.*, 2008). *Z. indianus* was reported in Panama and Florida, USA (van der Linde *et al.*, 2006), Mexico (Castrezana, 2007), and Canada (Renkema *et al.*, 2013).

The pest is a polyphagous fly (Pasini and Link, 2011). With its almost 80 host plants, it is considered the most ecologically diverse drosophilid in the Afrotropical region (Yassin and David, 2010). In Florida, the Department of Agriculture and Consumer Service issued a pest alert for the presence of *Z. indianus* in commercial orchards like guava, pond apple, barbados cherry, cashew, pomegranate and sweet orange (Steck, 2005). In

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the south of Pennsylvania, it was reported to have a potential damage to small fruits (cherries, blueberries, blackberries, and raspberries) and grapes (Biddinger *et al.*, 2012). In Brazil, the fly has been found in several commercial fruits, including citrus (Steck, 2005). Also, the pest was recorded on several host plants such as prickly pear, guava, papaya, mango, carambola and peach from different localities in northeastern Argentina (Lavagnino *et al.*, 2008).

Z. indianus was recorded for the first time in several Middle Eastern countries. Amoudi *et al.* (1991) reported this fly from Saudi Arabia on pomegranate fruits in Taif area, Makkah Province. In Egypt, Yassin and Abou-Youssef (2004) recorded this species from the oases of the Northern-Western Desert of Egypt. Zinette (2009) mentioned that larvae of this pest were found associated with larvae of the Medfly, *Ceratitis capitata* in kiwi fruits in the coastal area of Lebanon. Al T'Oma *et al.* (2010) recorded *Z. indianus* from Basra Province in Iraq on nabq (*Ziziphus zizyphus*), date palm, grape, fig and banana.

Jordan has a unique topography that varies sharply in short distances, which includes different climatic regimes in adjacent areas (Freiwan and Kadioglu, 2008). Fruit trees are grown in Jordan Valley and high lands in irrigated and rain-fed areas. In rain-fed northern and

central areas of higher elevations, pome fruits, stone fruits and olives are cultivated; while in Jordan Valley, fruits such as citrus and date palm are produced in surplus amounts. Al-Jboory and Katbeh-Bader (2012) recorded *Z. indianus* for the first time on date palms (var. Madjuol) from one locality in Central Jordan Valley in June 2012.

No data was available concerning the distribution, the hosts or pest status of this species in Jordan. In addition, it was not known if the pest was just recently introduced or may have been established in Jordan for longer time. Therefore, the objectives of this research were to study the distribution and host range of this newly recorded fly providing basic data which may be necessary to any control program of this pest in Jordan.

2. MATERIALS AND METHODS

2.1. Sampling sites

Field trips were conducted to different fruit tree orchards during the period from February to August 2013. A total of 18 locations were visited. These locations were in the Jordan Valley, the high lands and the desert (Fig.1). One or more visits were conducted to the same location during different time intervals (Table 1).

Table 1. Sampled locations, their coordinates, elevations and sampling months in 2013.

Jordan Valley			
Location	Latitude/ Longitude	Elevation (m)	Sampling Months
Ma'addi	32°10'N/ 35°37'E	- 200	August
Al Mashara'	32°25'N/ 35°35'E	- 207	February
Sharhabeel Ben Hasnah	32°33'N/35°50'E	- 213	March
Al Karama	31°57'N/ 35°34'E	- 215	August
Dayr Alla	32°12'N/35°37'E	- 220	February, June, July
Al Shuna Al Janubiyya	31°53'N/35°37'E	- 240	June

High lands			
Souf	32°18'N/35°50'E	570	August
Wadi Al Salt	32°01'N/ 35°43'E	650	May, July, August
Na'our	31°52'N/ 35°49'E	720	August
Ar Rumaymeen	32°07'N/ 35°48'E	750	August
Mushaqar	31°47'N/ 35°46'E	790	August
Ajloun	32°20'N/ 35°44'E	800	August
Wadi Al Sir	31°57'N/ 35°49'E	907	August
Al Salt	32°03'N/ 35°43'E	986	June, July, August
Al Shawbak	30°30'N/ 35°32'E	1460	July, August
Desert			
Al Zarqa'	32°04'N/ 36°06'E	570	July
Umm Al-Jimal	32°19'N/ 36°21'E	710	June
AD Disa	29°32'N/35°44'E	1320	July

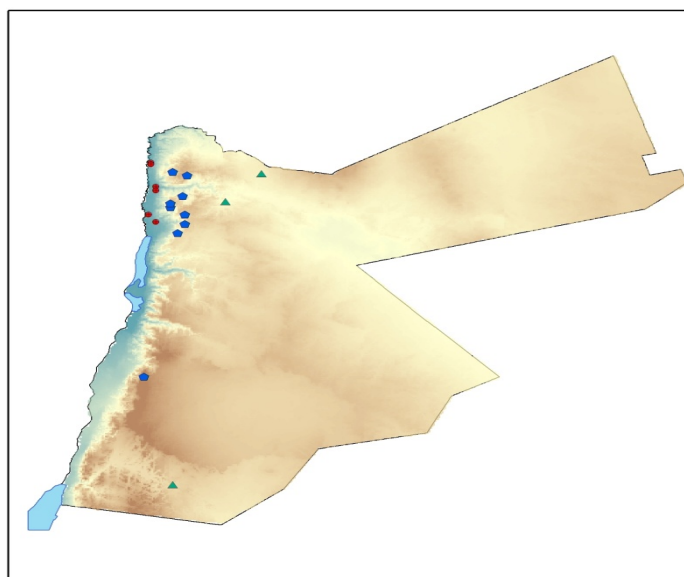


Fig. 1: Locations of fruit trees orchards sampled for *Z. indianus* in Jordan, ○ Jordan Valley, △ highlands, and □ desert.

2.2. Fruit sampling

Three sampling methods were employed to collect *Z. indianus*:

1) **Net sweeping:** Flies observed flying over decomposing or rotting fruits dropped on the ground were sampled by sweeping net. The specimens were

preserved in 75% ethanol and then examined for the presence of *Z. indianus*. The sampled hosts were: Mandarin orange, tomato, Christ's thorn, grapes, figs, nectarine, pomegranate and guava.

2) **Collecting fallen fruits:** Fallen fruits were collected when 1-20% exposed pulp was seen according

to Leão and Tidon (2004). Collected fruits were stored in plastic containers, capped with a fine cloth, and then transported to the laboratory until adult emergence. The total number of emerged flies (different species of Drosophilidae, Tephritidae and others) were counted, and *Z. indianus* % was calculated. Collected fruit samples were: sweet orange, sour orange, grapes, figs, peach, blackthorn, date palm, pomegranate, guava, and apple. Since this fly was known to be a serious pest on figs (Steck, 2005), special attention was paid to figs and the following fig varieties were sampled: Klabee, Hmaree, Byadee, Esalee, Swadee, Zrakee, Khdaree, Mwazee, and Brazilian fig.

3) Banana baited traps: These traps were 0.6 L volume, colorless plastic bottles containing mashed banana fruits and seeded with dry and active yeast *Saccharomyces cerevisiae* (Tidon and Sene, 1988). The traps were placed in several commercial fruit orchards for 5-6 days, about 1.5-1.7 m from the ground in the northern direction of the canopy at the rate of 3 traps/ha. The percentages of adult of *Z. indianus* were determined as above. Sample fruits were:

mulberry, grapes, peach, figs, date palm, nectarine, plum and apple.

For each sample, the location, fruit variety and sampling date were recorded. *Z. indianus* was identified using identification keys and species descriptions (Gupta, 1970; van der Linde, 2010; Yassin and David, 2010).

3. RESULTS AND DISCUSSION

Zaprionus indianus was collected from many hosts planted in different geographical areas of Jordan using different sampling methods. It was found associated with other *Zaprionus* spp. or Drosophilid species.

1) **Net sweeping:** The pest was found flying over all the sampled fruits (Mandarin orange, tomato, Christ's thorn, grapes, figs, nectarine, pomegranate and guava) (Table 2). It was first collected in February from a citrus orchard in the warmer Central Jordan Valley, then it was found on tomato grown under green houses in April, and later on, it was found in June on tomato grown in open-field in Al Mafraq. In July, the pest was found on grapes, figs and nectarine, while in August, it was found on pomegranate and guava.

Table 2. Hosts of *Z. indianus*, their locations and collecting dates in 2013.

Location	Fruit sample / variety	Date
Dayr Alla	Mandarin orange (<i>Citrus reticulata</i>) / Clementine	18 Feb.
Al Karama	Tomato (<i>Solanum lycopersicum</i>) / Newton	17 April
Dayr Alla	Christ's thorn (<i>Ziziphus spina-christi</i>) / Baladee	2 June
Umm Al-Jimal	Tomato (<i>Solanum lycopersicum</i>) / Newton	16 June
AD Disa	Grapes (<i>Vitis vinifera</i>) / Thompson seedless	4 July
AD Disa	Fig (<i>Ficus carica</i>) / Brown turkey	4 July
Al Zarqa'	Fig (<i>Ficus carica</i>) / Khdaree	16 July
Al Shawbak	Nectarine (<i>Prunus persica</i> var. <i>nucipersica</i>) / Snow queen	20 July
Al Shawbak	Fig (<i>Ficus carica</i>) / Khdaree	22 July
Ar Rumaymeen	Pomegranate (<i>Punica granatum</i>) / Hlawe	7 Aug.
Al Salt	Pomegranate (<i>Punica granatum</i>) / Khdaree	13 Aug.
Ma'addi	Guava (<i>Psidium guajava</i>) / Balade	25 Aug.

2) **Collecting fallen fruits:** 28 samples of fallen fruits were taken from 12 locations (Table 3). The percentage of emerged adults of *Z. indianus* from collected fallen fruits ranged from 9.0-99.1% during February-August. The minimum percentage was recorded from sweet orange fruits collected from Northern Jordan Valley during February, while the maximum percentage was obtained from Brazilian fig fruits collected from Southern Jordan

Valley during June. The hosts were found to be sweet orange, sour orange, grapes, Brazilian fig, peach, blackthorn, fig, date palm, pomegranate, guava and apple. Because fallen fruits were found to be a primary feeding and breeding source of the flies, removing fallen fruits and destroying them will greatly reduce the fly populations in next generations.

Table 3. Adult *Z. indianus* % emerged from fallen fruits of different hosts.

Location	Fruit sample / variety	Date	<i>Z. indianus</i> (%)
Almashara'	Sweet orange (<i>Citrus sinensis</i>) / French	21 Feb.	9.0
Sharhabeel Ben Hasnah	Sour orange (<i>Citrus aurantium</i>) / Seville	6 March	12.5
Dayr Alla	Grapes (<i>Vitis vinifera</i>) / Superior Seedless	12 June	91.9
Al Shuna Al Janubiyya	Brazilian fig (<i>Ficus carica</i>) / Brazilian	12 June	99.1
Umm Al Jimal	Peach (<i>Prunus persica</i>) / Royal Sun	16 June	60.8
Wadi Al Salt	Blackthorn (<i>Prunus pinosa</i>)	19 July	50.0
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Klabee	4 Aug.	80.1
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Hmaree	4 Aug.	85.4
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Byadee	6 Aug.	74.4
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Esalee	6 Aug.	72.8
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Swadee	6 Aug.	77.8
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Zrakee	6 Aug.	75.7
Naour	Peach (<i>Prunus persica</i>) / Sweet Cap	8 Aug.	91.0
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Khdaree	11 Aug.	84.6
Wadi Al Salt	Fig (<i>Ficus carica</i>) / Mwazee	11 Aug.	73.1
Al Karama	Date palm (<i>Phoenix dactylifera</i>) / Barhi	21 Aug.	88.2
Al Shawbak	Fig (<i>Ficus carica</i>) / Khdaree	26 Aug.	75.6
Al Shawbak	Pomegranate (<i>Punica granatum</i>) / Khdaree	26 Aug.	18.5
Al Karama	Guava (<i>Pisidium guajava</i>) / Balade	28 Aug.	85.3
Souf	Grapes (<i>Vitis vinifera</i>) / Khdaree	18 Aug.	88.9
Souf	Pomegranate (<i>Punica granatum</i>) / Khdaree	18 Aug.	89.9
Souf	Apple (<i>Malus domestica</i>) / Early Gold	18 Aug.	71.4
Souf	Fig (<i>Ficus carica</i>) / Mwazee	18 Aug.	65.7
Souf	Fig (<i>Ficus carica</i>) / Khdaree	18 Aug.	74.4

Location	Fruit sample / variety	Date	<i>Z. indianus</i> (%)
Ajloun	Grapes (<i>Vitis vinifera</i>) / Khdaree	18 Aug.	61.1
Wadi Al Sir	Fig (<i>Ficus carica</i>) / Hmaree	19 Aug.	94.4
Wadi Al Sir	Fig (<i>Ficus carica</i>) / Zrakee	19 Aug.	76.9
Wadi Al Sir	Fig (<i>Ficus carica</i>) / Mwazee	19 Aug.	54.8

3) **Banana baited traps:** *Z. indianus* adult flies percent captured in banana baited traps ranged from 49.7-93.3% during the period from May to August. The lowest percent was in June on peach fruits in Al Balqa'a, while the highest percent (93.3%) was in July on date palm fruits in Central Jordan Valley (Table 4). The pest was collected from orchards planted with Alpine nectarine, Angeleno plums, Gloster apples, Khdaree figs, Madjuol date palm, May Crest peaches, Merrill Sundance peaches, Red Globe grapes, Superior seedless grapes and White mulberry.

Our results showed that the African fig fly had a wide host range which agrees with the finding of Yassin and David (2010) who reported about 80 host plant species for this pest. We reported the pest on pomegranate and sweet orange which was also mentioned by Steck (2005). Lavagnino *et al.* (2008) listed several hosts of the pest, including guava and peaches, which were confirmed as hosts in this study. Amoudi *et al.* (1991) found the pest on pomegranate fruits in Saudi Arabia which agrees with our results that showed pomegranate as a host. In addition, results of this research confirmed the findings of Al-Jboory and Katbeh-Bader (2012) who recorded *Z. indianus* on date palms.

In general, in all surveyed locations and host plants, the percentages of *Z. indianus* sampled by collecting fallen fruits and banana baited traps methods increased gradually from February to August. This increase might be due to the gradual increase in temperature and in the diversity of available food resources which favored the

reproduction of *Z. indianus*. In warm areas as Deir Alla, the percentages of captured flies in grapes in June and date palm in July were as high as 75.0% and 93.3%, respectively. In high lands of Al Salt, the percentage of captured flies in peaches' orchards in June and fig orchards in July was 49.7% and 83.7%, respectively.

Z. indianus seems to attack only over-ripe and damaged fruits because it does not have a large and sharp ovipositor (Biddinger *et al.*, 2012). However, when fallen fruits were sampled, it was found adapted to several native food resources in Jordan especially on figs which showed high percentage of *Z. indianus* mainly on Hmaree variety (up to 94.4%) and khdaree variety (up to 84.6%). These varieties are well accepted for fresh consumption and they are the most popular commercially cultivated varieties. Also they have green fruits with an open and large ostiole and easily develop cracks more than other varieties, which favor the attack of *Z. indianus*.

In addition, the flies fed on different introduced fruit varieties such as Brazilian fig, date palm and grapes. Among these, Brazilian figs showed the highest percentage of *Z. indianus* in collected fallen fruits (99.1%) followed by date palm (Madjoul variety) with 93.3% of *Z. indianus* captured by banana baited traps. The loss estimates in fig production in Brazil since its appearance was around 50%, which became the most important plague on figs in less than two years from the first report (Gomes *et al.*, 2003). Heavy losses on figs were observed during our study, but no quantitative research was

conducted to document the losses which shows the need for such studies in the future. It also caused a substantial commercial damage in orange and peach orchards (Santos *et al.*, 2003). It was observed that *Z. indianus* attack on date palm fruits (unripe and ripe) occurred in presence of cracks, infestation holes or bird attack and the infestation caused rapid decay of fruits due to the high biotic potential and short life cycle of *Z. indianus*.

It was assumed that *Z. indianus* may have been introduced into Jordan through the importation of infested fruits from neighboring countries such as Palestine, Lebanon or Saudi Arabia (Al-Jboory and Katbeh-Bader, 2012). Thus, since the fly was found widely-distributed in Jordan on many hosts, it is most

likely present in Jordan for long time and may have been overlooked and mistaken with other *Dorosophila* spp. assuming that it may be a secondary pest.

Future studies may be necessary to be conducted during autumn and winter on other non-studied fruit species such as citrus, banana and newly introduced varieties of tropical fruits as avocado, mango and guava. Locations with large fruit cultivation areas (date palm, stone fruits, pome fruits and citrus) that were not explored in this study such as Aqaba, Azraq, Wadi Arabah and high lands needs to be studied. The economic injury level and economic threshold of *Z. indianus* on figs and date palms should be determined to provide the necessary data to integrated management of the pest.

Table 4. Percentage of adult *Z. indianus* in banana-baited traps.

Location	Fruit sample / variety	Date	<i>Z. indianus</i> (%)
Wadi Al Salt	Mulberry (<i>Morus alba</i>) / White Mulberry	24 May	51.0
Dayr Alla	Grapes (<i>Vitis vinifera</i>) / Superior Seedless	12 June	75.0
Al Salt	Peach (<i>Prunus persica</i>) / May Crest	25 June	49.7
Al Salt	Fig (<i>Ficus carica</i>) /Khdaree	5 July	83.7
Dayr Alla	Date palm (<i>Phoenix dactylifera</i>) / Madjuol	5 July	93.3
AD Disa	Nectarine (<i>Prunus persica</i> var. <i>nucipersica</i>) /Alpine	4 July	86.3
Al Shawbak	Peach (<i>Prunus persica</i>) / Merrill Sundance	17 Aug.	73.9
Al Shawbak	Plum (<i>Prunus salicina</i>) /Angeleno	17 Aug.	88.8
Al Shawbak	Apple (<i>Malus domestica</i>) /Gloster	17 Aug.	62.5
Al Shawbak	Grapes (<i>Vitis vinifera</i>) /Red Globe	17 Aug.	68.3
Mushaqar	Fig (<i>Ficus carica</i>) /Khdaree	21 Aug.	61.5

4. CONCLUSION

Data about the distribution and hosts of *Z. indianus* are presented for the first time in Jordan. The fly was found to be widely distributed with variable infestation densities on native and introduced hosts especially on figs and date palms causing serious damage. Sampling the fly by collecting fallen fruits contributed in

determining the host range of the fly. Banana baited traps were found effective to collect the fly and is suggested for monitoring purposes of this pest.

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التوزيع الجغرافي والعوائل لنزابة التين الافريقية في الأردن (Diptera: Drosophilidae) *Zaprionus indianus*

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ملخص

تم تسجيل ذبابة التين الافريقية، *Z. indianus*، في الأردن لأول مرة كأفة على أشجار النخيل (صنف مجهول) في الاغوار الوسطى في يونيو 2012. أجريت رحلات ميدانية لمختلف بساتين أشجار الفاكهة خلال الفترة من فبراير إلى أغسطس 2013 في وادي الأردن والأراضي المرتفعة والصحراء. اخذت عينات من الحشرات الطائرة فوق الثمار الساقطة على الأرض بواسطة الشبكة. تم أيضا جمع عينات من الثمار الساقطة ونقلت الى المختبر وحضنت حتى ظهور الحشرات البالغة. وضعت مصائد موز تحتوي على خميرة جافة ونشطة في عدة بساتين فاكهة تجارية. أظهرت النتائج أن الذبابة موجودة في النظم البيئية المختلفة على عدد من العوائل. حيث سجلت الحشرة على العديد من الفواكه مثل التوت والعنب والخوخ والنكتارين والبرقوق والتين والنخيل والبرتقال الحلو والبرتقال الحامض، وبرقوق السياج والرمان والجوافة والتفاح. بلغت اقل نسبة خروج للبالغات 9 % على الثمار التي جمعت من شمال وادي الأردن خلال شهر شباط، وكانت اعلى نسبة خروج 99.1 % من ثمار التين التي جمعت من جنوب وادي الأردن خلال حزيران. وكانت ادنى نسبة للأفة في مصائد الموز 49.7 % والتي جمعت من حقل دراق في حزيران من منطقة السلط، وكانت اعلى نسبة 93.9 % على النخيل في دير علا بشهر حزيران. قدمت نتائج البحث معلومات الأساسية والضرورية لتنفيذ اللازمة برامج مكافحة ضد الآفة.

الكلمات الدالة: ذبابة التين الافريقية، المدى العائلي لحشرة *Zaprionus indianus*، التوزيع الجغرافي، التين، الأردن.

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