

## **Host range, damage and seasonality of fruit flies in Sennar State, Sudan**

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### **ABSTRACT**

Fruit flies (Diptera: Tephritidae) are one of the most economically important groups of insects in the afrotropical region because they cause damage to fruits and vegetables. Integrated fruit fly (FF) control program requires accurate data about taxonomy, incidence, distribution and seasonality of the members of this pest. Surveys and collection missions were carried out in Sennar State during January 2006- January 2008. Yellow sticky traps were used for adult collection. Trapped fruit flies were labeled, identified and counted monthly to estimate their abundance throughout the year. In addition, infested fruits of mango, guava, grapefruit, orange, banana, melons, pumpkin, watermelon, and the wild magad (Cucurbitaceae) were collected monthly from the surveyed areas. Larvae were reared till the adult stage and identified. Field infestation rate of FF species was determined on mango and guava at Singa area. Percentage of FF infestation on mango Baladi cultivar was 10% in March, 15% in April and 20% in May. During the period from June to August, Abu Samaka cultivar was the only mango cultivar available, and accordingly, was subjected to a heavy attack by the FF. The infestation reached 30% in June and 50% in July. The FF moved to guava, during the period from October to December. The rate of FF infestation on guava was very high during this period and ranged from 80% to 90%. Mango fruits in Singa area were infested by *Bactrocera invadens* (Drew, Tsuruta and White) (80%), *C. cosyra* (19.8%) and *Dacus longistylus* (Wiedemann) (0.2%) of the total emerged adults. This was the first record for the latter species in a host other than *Calotropis procera* (Apocynaceae).

Guava fruits were infested by *B. invadens* (84.5%), *C. cosyra* (15.3%), and *C. quinaria* (Bezzi) (0.2%) of the total emerged adults. *B. invadens* seemed to out-compete and replace the indigenous species. Cucurbit fruits hosted *D. ciliatus* (Loew) only. The wild magad fruits hosted *B. invadens* and *B. cucurbitae* (Coquillet). The highest population of *B. invadens* was observed during July and December (254 and 253 adults/trap, respectively). March and April showed the lowest population due to higher temperatures and low relative humidity.

## INTRODUCTION

The Dipterous family Tephritidae (Trypetidae) is represented in all world regions, except Antarctica. *Bactrocera* spp. (formerly included in *Dacus*) are natives to tropical Asia, Australia, and the south Pacific regions, with a few species found in Africa and warm-temperate areas of Europe and Asia. The rest of the genus is associated with a wide range of fruits predominantly of tropical wet forest origin. Some *Bactrocera* spp. have been established in Hawaii, Guiana and Surinam due to fruit movement. *Ceratitis* spp. attack a wide range of fruits, and are native to tropical Africa. *C. capitata* (Wiedemann) has been established in all other world regions, except Asia. *Dacus* spp. are almost all associated with the flowers and fruits of Cucurbitaceae or with pods of Asclepiadaceae and most species are found in Africa. All *Dacus* species attacking mango have recently been placed in the genus *Bactrocera*. *Dacus ciliatus* (Loew) has become established in the Indian subcontinent and in the Indian Ocean Islands (White and Elson-Harris, 1992). *Anasterpha* spp. are endemic to the western hemisphere and their range extends from the southern United States to the northern Argentina and includes the Caribbean Islands (Aluja, 1994). *Rhagoletis* spp. are found in South and Central America, mostly infesting Solanaceous plants, and in the temperate areas of Europe and North America, where most species are infesting fruits. The most important pest species are associated with Rosaceae and some of these have the potential to become established in new areas (White and Elson-Harris, 1992). Most mango-producing countries are located in the FF infested areas, and producers suffer significant direct and indirect economic losses resulting from FF damage (Aluja, 1994).

Annual production of mangoes in Africa was estimated to be 1.9 million tons; about 40% of which was lost due to FFs. Fruits infestation rates vary among countries and seasons, ranging from 5-100% (Lux *et al.*, 2003).

In the Sudan, the production and export of fruits and vegetables is seriously affected by the FFs. Infestation and damage by *C. cosyra* on mango crop ranged between 85-90% (Gubara and Abu Elgasim, 2004). The Ministry of Agriculture and Forestry declared them as national pests similar to rats, birds and locusts. Sennar State was selected for carrying out this study because it is the largest fruit producing State in the Sudan (Rajab, 2005). Fruits grown in this area include banana, guava, mango, orange, grapefruit and lime, in addition to vegetable crops. This diversification provides continuous food supply and shelters for the FFs throughout the year leading to heavy infestations by fruit flies. Knowledge about the Tephritidae spectrum in any given area is a prerequisite for the adoption of an IPM program. Therefore, the objectives of this study were to determine the seasonal abundance, incidence and fluctuations of fruit fly species in orchards and to evaluate the damage caused to mango and guava fruits, at Sennar State.

## MATERIALS AND METHODS

Surveys and collection missions were conducted at Sennar State at two sites: Singa (Alazaza), (longitude 33<sup>0</sup> 56', latitude 13<sup>0</sup> 10'), and Sennar area, (longitude 33<sup>0</sup> 33', latitude 13<sup>0</sup> 32'). Both sites are located on the western bank Blue Nile, 386 km and 286 km south of Khartoum, the capital city of the Sudan, respectively. Investigations were carried out for two years, from January 2006 to January 2008. The seasonal abundance, *i.e.* population incidence of FF species, was monitored using yellow sticky traps. This type of trap has the ability to attract different FF species, in addition to other non-targeted insects present in the same area. A number of locally made yellow sticky traps (30 cm x 40 cm) made from wood and covered with a yellow plastic material were painted with Altirat (sticky material). They were designed to provide large yellow surface area, so as to enhance their trapping efficiency. These traps are cheap and easy to make. They were hanged on branches of mango trees in an orchard at Sennar, and on mango and guava trees in Singa area, at a height of two meters

above ground to attract adult insects. Twelve traps were used in each site; they were distributed randomly in the orchards on the fruit bearing trees keeping 50 m between the traps. Trapped FFs were labeled, identified and counted monthly to estimate their abundance throughout the year. Possibly, new entered or evolved species that seemed to exhibit morphological differences were kept to be identified later. The yellow plastic covers and the sticky materials were changed simultaneously after each count.

Infested fruits of mango, guava, grapefruit, orange, banana, cucurbits, such as melons, pumpkin, watermelon, and magad were collected monthly from the surveyed areas. Infestation was recognized by the presence of larvae or by symptoms of ovipunctures made by the female. Necessary data such as date of collection, name of the host and locality were recorded. Infested fruits were transported for rearing facilities at the Biology Laboratory, Faculty of Agricultural Sciences, University of Gezira. Larvae were reared till the adult stage and identified.

Mango and guava fruits were collected during the harvesting season 2006-2007, to estimate damage caused by fruit flies. One hundred fruits were taken from each cultivar and sorted into infested and non-infested fruits. Infested fruits were recognized by the presence of larvae. Fruits with symptoms of oviposition punctures were kept in the laboratory to confirm their infestation by placing them in glass jars till the development of infestation (rottening of fruit and appearance of larvae) and finally the total number of infested fruits was counted.

## RESULTS AND DISCUSSION

Results show that mango fruits grown in Singa were infested by three species, *viz.* *Bactrocera invadens* constituting 80% of the detected FF populations, *Ceratitis cosyra* constituting 19.8%, and *Dacus longistylus*, which forms about 0.2% of the total emerged adults. This is the first time for the latter species to be recorded on a host other than Ushar plant, *Calotropis procera* (Apocynaceae). *D. longistylus* might become one of the most serious pests in the future. Guava fruits were found to be infested by the two species, *B. invadens* that accounts for 84.5%, and *C. cosyra* (15.3%), in addition to *C. quinaria*, which accounts for 0.2% of the total emerged adults (Table

1). Mango grown in Sennar was infested by the same two species, *B. invadens* (89%), and *C. cosyra* (11%) of the total emerged adults (Table 2). *C. cosyra* was known as the dominant FF species attacking mango (the main host) and guava in the Sudan (Ahmed *et al.*, 2003). From these results, it appears that *B. invadens* was able to compete successfully and strongly with *C. cosyra* in its preferred host fruits. This agreed with Mwatawala *et al.* (2006), who stated that beside being a good disperser, *B. invadens* also appears to be an aggressive invader dominating several of the indigenous pest species.

Reared out larvae from infested banana fruits showed emergence of only *B. invadens*. Infested cucurbit fruits collected during January, February and December showed emergence of only *D. ciliatus*. The collection of the infested fruits from Magad during February showed emergence of *B. invadens* while those collected during December showed emergence of *B. cucurbitae* (Table 1) and this is the first record in Sudan for this wild plant as a host for fruit fly species, indicating that in some cases unrelated hosts are more likely to be attacked when preferred hosts are absent. Thus, from the data shown in Tables 1 and 2, *B. invadens* was the most dominant species in the study areas.

Field infestation rate of FF species was determined on mango and guava fruits at Singa area. Percentage of infestation on Baladi cultivar was 10% in March, 15% in April and 20% in May. During the period from June to August, Abu Samaka cultivar was the only mango cultivar available, and accordingly was subjected to a heavy attack by the FF. The percentage of infestation on Abu Samaka reached 30% in June and 50% in July. Regarding the period from October to December, the FF moved to guava, which was the only fruit available. The rate of FF infestation on guava was very high during this period and ranged from 80% to 90% (Fig. 1).

### **Distribution of species in mango and guava**

*B. invadens* appears to be the dominant species, which attacks mango fruits in Singa area. It is present during the fruiting season of mango, *i.e.* from March to July (Fig. 2). *B. invadens* was also the dominant species that attacked guava fruits in Singa area throughout the fruiting season of guava, exhibited an extremely high percentage

of 90%, 100%, 80%, 100%, 100% and 100% of the total emerged adults during January, February, June, July, November and December, respectively. *C. cosyra* attacked guava only during June (92%), while *C. quinaria* appeared during January and scored (1%) (Fig. 3).

The population of *C. cosyra* was relatively low, compared to that of *B. invadens*. It was absent during January and February, and appeared in June in a higher percentage (70%), then it declined to 25% and 6% of the total adult population in November and December, respectively (Fig. 2).

*B. invadens* was also the dominant FF species that attacked mango fruits in Sennar during January (100%), February (100%) and June (100%), while *C. cosyra* appeared only during June, and it scored 34% of the total adult population (Table 2).

The relative abundance of *B. cucurbitae*, *C. cosyra* and *C. quinaria* seems to be affected by the recently introduced alien *B. invadens*. It appears that this species is out competing and replacing the indigenous pests, a phenomenon that has been observed repeatedly in FF invasion (Duyck *et al.*, 2004). Also, Gesmallah (2011) (unpublished data) found that *B. invadens* was the dominant fruit fly species in Gezira State representing 98.4% of fruit fly composition replacing the indigenous species *C. cosyra*, which now represented only 0.03% of fruit fly composition. *B. invadens* frequently share the same fruit with the species *C. cosyra* but often occurred at higher numbers than the later.

### **Seasonality of species**

*B. invadens*, *C. cosyra* and *B. cucurbitae* were frequently the three FF species caught by yellow sticky traps hanged on mango and guava trees (Figs. 4, 5, 6). Results show that *B. invadens* was present on mango in Singa throughout the year. The highest population was observed during July (254), November (109) and December (253) adults/trap (Fig. 4). March and April showed the lowest population (1 adult/trap) and this was probably due to the high temperature and low relative humidity during these months. Ahmed *et al.*(2003) also found that fruit fly population had a negative correlation with temperature and a positive one with relative humidity. Population of *C. cosyra* and *B. cucurbitae* in Singa area was very low compared with that of *B.*

*invadens* (Fig. 4). Although *B. cucurbitae* was present in the orchard, it did not attack mango fruits.

Numbers of *B. invadens* caught by the yellow sticky traps hanged on mango trees in Sennar were very low compared to those caught in Singa (Fig. 5). This could be attributed to the intensive growing of guava trees. Guava fruits were considered the most important hosts for *B. invadens*.

*C. cosyra* and *B. cucurbitae* were very rare; their monthly counts during the year ranged between 0-2 adults/trap (Fig. 5). Numbers of *B. invadens* caught using the yellow sticky traps hanged on guava trees in Singa increased during the fruiting season of guava (Fig. 6). They showed 54, 65, 510 and 41 adults/trap during July, November, December and January, respectively. Between February (2006) to January (2007) it showed the lowest population of 1 to 10 adults/trap. *B. cucurbitae* scored 14 adults/trap during February, and disappeared during March-November. Two and three adults/trap were reported in December and January, respectively. *C. cosyra* appeared only during May and June at 1 and 4 adults/trap, respectively (Fig.6).

## CONCLUSIONS

- 1- *B. invadens*, *C. cosyra* and *B. cucurbitae* were the most common FF species trapped by the yellow sticky traps hanged on mango and guava trees in Sennar State.
2. Mango fruits in Singa were infested by three species namely, *B. invadens*, *C. cosyra* and *D. longistylus*, while guava fruits were infested by the former two species, in addition to *C. quinaria*.
3. *Bactrocera invadens* was the dominant FF species attacking mango and guava fruits all year round in Sennar State, the infestation rate was higher in guava and Abu Samaka mango cultivar compared to Baladi mango cultivar.
4. Cucurbit fruits were infested by *D. ciliatus*, while the wild magad fruits were infested by *B. invadens* and *B. cucurbitae*.

## ACKNOWLEDGEMENTS

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Table 1. Incidence of FF species in different plant hosts at Singa (January-December, 2006) expressed as % of reared adult population.

Species Hosts	<i>C. cosyra</i>	<i>C. quinaria</i>	<i>B. invadens</i>	<i>B. cucurbitae</i>	<i>D. ciliatus</i>	<i>D. longistylus</i>
Mango	19.8	-	80	-	-	0.2
Guava	15.3	0.2	84.5	-	-	-
Banana	-	-	100	-	-	-
Cucurbits	-	-	-	-	100	-
Magad	-	-	50	50	-	-

Table 2. Incidence of FF species in mango at Sennar expressed as % of reared adult population.

Species Months	<i>C. cosyra</i>	<i>B. invadens</i>
January	0	100
February	0	100
June	34	66
Average	11	89

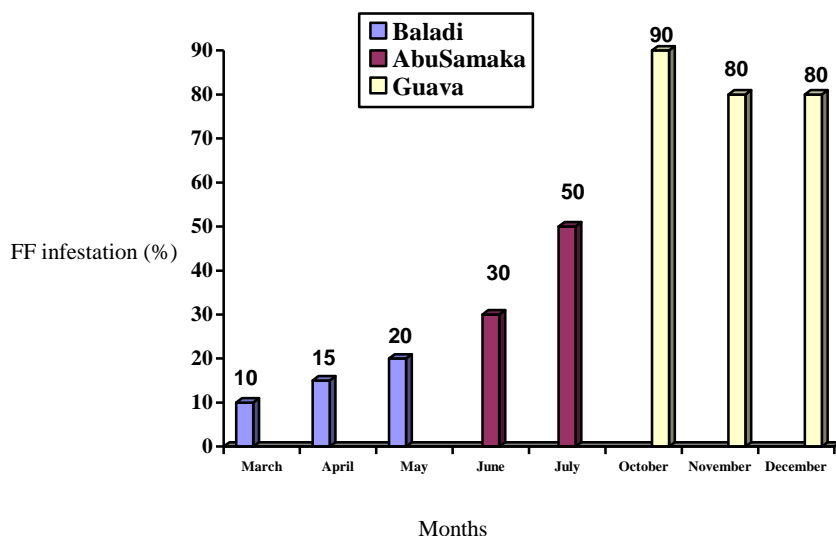


Fig. 1. Percentage of infestation by *B. invadens* and *C. cosyra*, on mango (Baladi and Abu Samaka) and guava in Singa area.

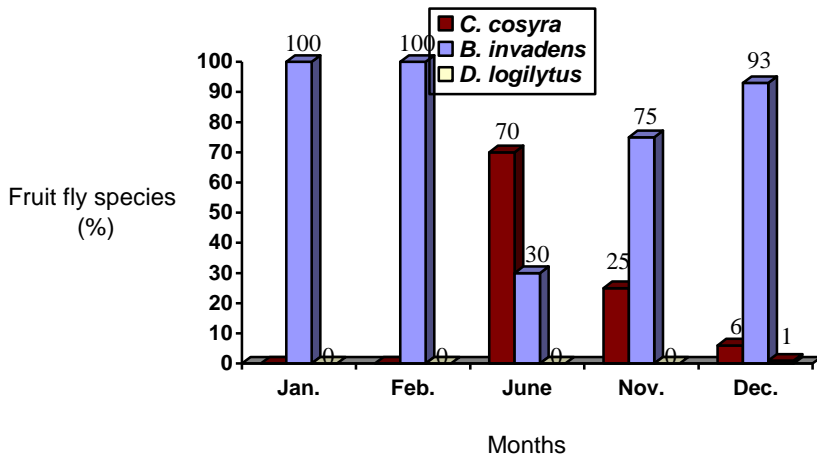


Fig. 2. Percentage of FF species infesting mango fruits, January to December 2006, Singa area.

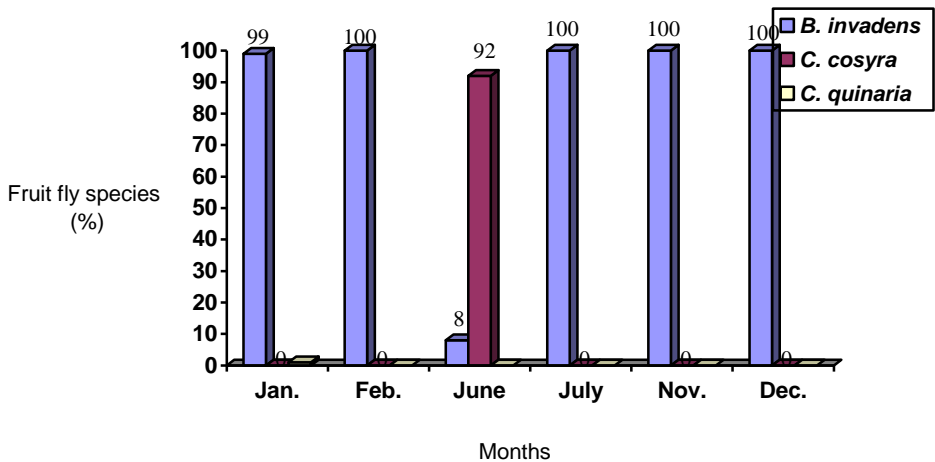


Fig. 3. Percentage of FF species infesting guava during January-December 2006 at Singa area.

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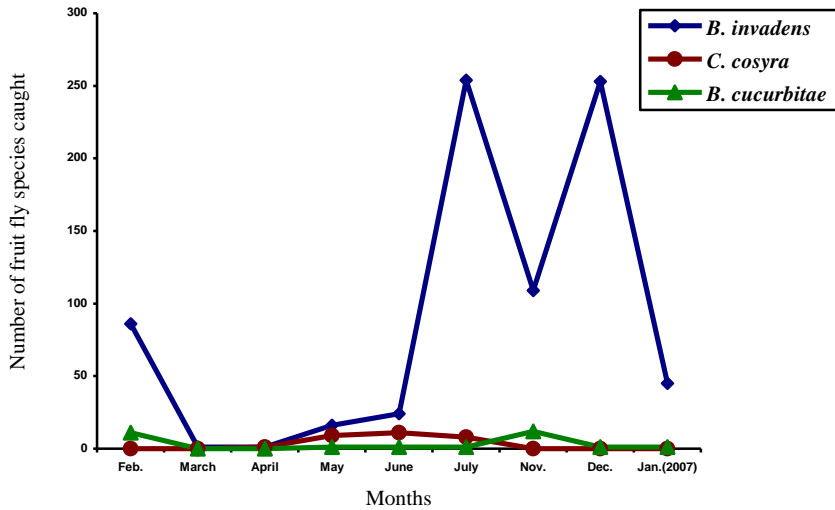


Fig. 4.

Monthly counts of FF species caught during February 2006 to January 2007 using yellow sticky traps hanged on mango, Singa area.

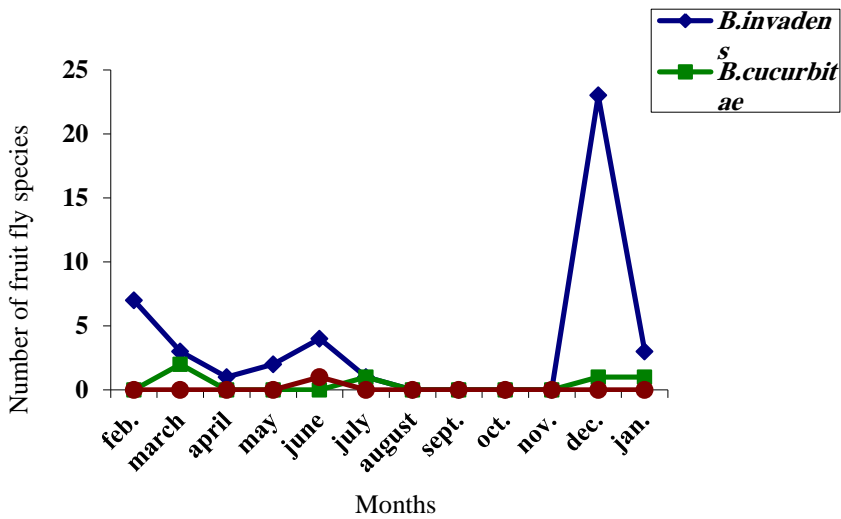


Fig. 5. Monthly counts of FF species caught during February 2006-January 2007 using the yellow sticky traps hanged on mango Sennar area.

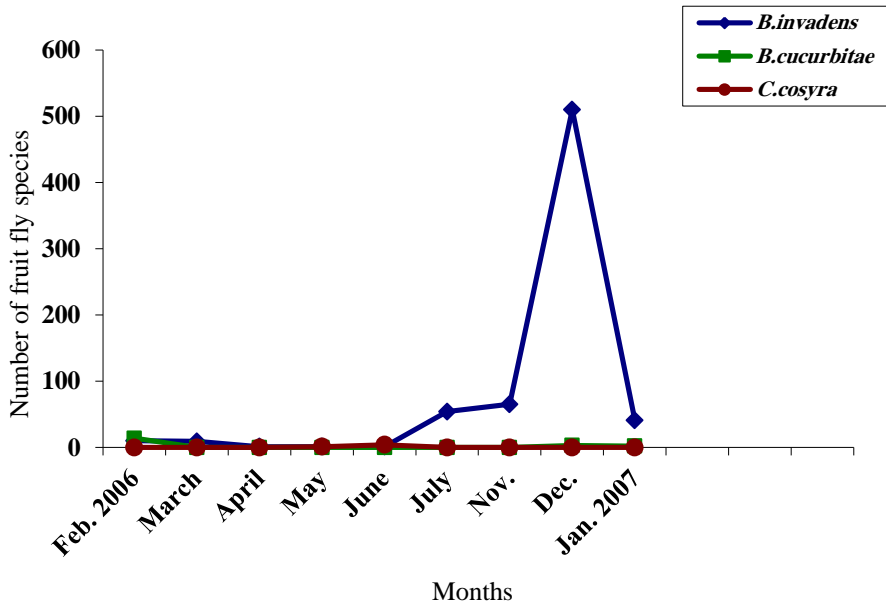


Fig. 6. Monthly counts of FF species caught during February 2006-January 2007 using the yellow sticky traps hanged on guava, Singa area.

النباتات العائلة والتلف وموسمية ذباب الفاكهة في ولاية سنار ، السودان

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الخلاصة

يعتبر ذباب الفاكهة (Diptera: Tephritidae) أحد أهم مجموعات الحشرات ذات الأهمية الاقتصادية في المنطقة الاستوائية من أفريقيا، لأنها تحدث تلفاً في الفاكهة والخضر. يتطلب البرنامج المتكامل لمكافحة هذه الآفة معلومات دقيقة عن تصنيفها، تواجدها، توزيعها وموسميتها. اهتمت هذه الدراسة بعمل المسوحات الحقلية وكذلك جمع وحصر العينات الحشرية في ولاية سنار في الفترة من يناير 2006-يناير 2008م. جمعت الحشرات الكاملة باستخدام المصائد الصفراء اللاصقة. أجريت عملية جمع الحشرات شهرياً لتحديد أنواع وإعداد ذباب الفاكهة في هذه الولاية خلال السنة. كذلك أجريت عملية جمع الثمار المصابة شهرياً لعدد من العوائل شملت المانجو والجوافة والقريب فروت والبرتقال والموز والقرعيات مثل الشمام والقرع والبطيخ إضافة إلى ثمار نبات المغد وهو نبات بري يتبع لعائلة القرعيات. ربيت اليرقات لحين خروج الحشرات الكاملة التي تم تصنيفها بعد ذلك. أيضاً خلال هذه الدراسة تم تحديد معدل الإصابة الحقلية لكل من المانجو والجوافة في منطقة سنجة حيث بلغت نسبة الإصابة في صنف المانجو بلدي 10% في شهر مارس، 15% في شهر أبريل و20% في شهر مايو. الفترة من يونيو إلى أغسطس هي فترة الإنتاج لصنف المانجو أبو سمكة ولذلك يتعرض إلى نسبة إصابة عالية تصل إلى 30% في يونيو و50% في يوليو. خلال الفترة من أكتوبر إلى ديسمبر تتحول الآفة إلى ثمار الجوافة مسببة 80-90% من التلف. أيضاً أوضحت الدراسة أن ثمار المانجو في سنجة تصاب بثلاثة أنواع هي *B. invadens* والتي تمثل 80%، *C. cosyra* والتي تمثل 19.8%، و *D. Longistylus* والتي تمثل 0.2%، وهي المرة الأولى للنوع الأخير الذي يتم

رصده خارج عائله الأساسي العشر *Calotropis procera*، أما الجوافة فقد وجد أنها تصاب بالنوع *B. invadens* والتي تمثل 84.5% و *C. cosyra* 15.3% و *C. quinaria* والتي تمثل 0.2%. هذه النتائج توضح أن النوع *B. invadens* نافس الأنواع الموجودة أصلاً وحلّ مكانها. ثمار القرعيات وجدت أنها تصاب بالنوع *D. ciliatus* أما ثمار نبات المقد فقد وجد على أنه يصاب بكل من *B. cucurbitae* و *B. invadens*. أعلى تعداد للنوع *B. invadens* لوحظ خلال يوليو وديسمبر وهو 253 و 254 حشرة كاملة لكل مصيدة. خلال شهري مارس وأبريل لوحظ أقل تعداد للأفة ويعزى ذلك لارتفاع درجات الحرارة وانخفاض الرطوبة النسبية خلال هذه الفترة.