# The Seasonal Flight Activity of the Olive Fruit Fly *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae) in the Central Highlands of West-Bank, Palestine

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## ABSTRACT

Olive (*Olea europaea* L.) is one of the most important fruit trees in Palestine. The olive fruit fly, *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae) is the most dangerous insect pest that affects olive trees in the Mediterranean region including Palestine. This study was conducted in Bethlehem during 2011-2012 to monitor the seasonal flight activity of *B. oleae* using sticky traps on two olive cultivars (Nabali and Baladi) in Bethlehem Governorate. The obtained data of trapped flies indicated that the flight activity of *B. oleae* started in early July in Hindaza site and continued until the end of November with three peaks. The first peak was recorded in August-September, the second was in October and the third one was in the mid November. Indeed, it was observed that the flight activity of the insect was affected mainly by temperature as well as humidity and reflected on the beginning of the flight activity as well as the insect generations. On the other hand, the obtained data confirmed that, throughout the season, the sticky yellow traps were more effecient in capturing *B. oleae* than the green sticky traps. However, red and blue traps rarely captured olive fruit flies.

**Keywords**: *Bactrocera oleae*, Trap, Olive, Palestine

## INTRODUCTION

Olive (*Oleae europaea* L.) is one of the most important fruit trees in Palestine. The number of olive trees reached 11.3 million trees in Palestine, cultivated in an area of 45,140 hectares, and constituted about 67% of the total planted area with fruit trees in Palestine (Palestinian Central Bureau of Statistics, 2010). Bethlehem governorate is located in central highlands of West Bank, described with hot summer and cold winter. The number of olive trees reached about 327 thousands trees, cultivated with an area of 1700 hectares, constituted about 32% of the total area planted to fruit trees in Bethlehem (Palestinian Central Bureau of Statistics, 2010). The olive fruit fly, *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae) is the most serious insect pest of olive trees in the world. It is known primarily from the Mediterranean area of Southern Europe, and is also found in North Africa, the Middle East, particularly Syria and Jordan (Al-Zaghal and Mustafa,1986; Al Mommany and Al Antary, 2008), and along the east coast of Africa to South Africa. It is generally agreed among olive fly researchers that this insect can survive and develop in any area of the world where olive trees are grown (Neuenschwander and Michelakis, 1978; Kapatos and Fletcher, 1983). If it is not controlled, crop losses may reach 80% in the oil producing areas and 100% in areas growing table olive cultivars (Broumas, *et al.*, 2002).

In Palestine, olive fruit fly have become a severe and regional problem with high importance. In the central highlands of West-Bank including Bethlehem governorate,

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the olive fruit fly was considered as the most damaging pest on olive fruit, and the damage level reached more than 70% on olive fruits (Omar, 2012) in Palestine.

During the last decade, olive fruit fly has been managed mainly by conventional insecticidal bait or cover sprays from the ground. However, the ecological and toxicological side effects of the extensive use of such chemicals, as well as the growing interest in organic olive production, have turned attention to alternative control methods (Belcari and Bobbio, 1999; Tsolakis and Ragusa, 2002; Broumas et al., 2002; Saour and Makee, 2004; Caleca et al., 2007).

This research study was conducted to monitor the seasonal flight activity of the *B. oleae* in Bethlehem governorate; and to determine the suitable time for mass trapping of *B. oleae* to control the pest.

## MATERIALS AND METHODS

To monitor the flight activity of olive fruit fly, two experiments were carried out as follows:

**1st Expirement: Study the Effect of Color on the Attracting Efficiency of Sticky Traps:**

This experiment was conducted in three sites (replications) in Bethlehem area (Battir: Hindaza and Tuqu', from 1st Jun, 2011 until 30th April, 2012. Four sticky colored traps (blue, green, red, and yellow) were used in each site.

Sticky rectangles poster-broads, with 15*25 cm dimension were used in all sites. One side of the trap was painted with adhesive paste (Rinifoot), (Polisobutene 80% PA).

In all treatments, the traps were hanged at a height of 1 to 2 m on olive trees, and were randomly distributed in each site. The trapped olive fruit flies were weekly counted and sexed male or females according to the presence of ovipositor in female fly that distinguish it from male fly. Sticky boards were weekly changed, and stored in the laboratory.

**2nd Experiment: Recording of the Seasonal Flight Activity of Olive Fruit Fly *B. oleae* in Bethlehem Area During 2011 and 2012.**

This experiment was conducted in three sites: Battir, Hindaza, and Tuqu', from 1st June 2011 until 30th April, 2012 then it continued in Hindaza site only until end of December, 2012. One Jackson pheromone sticky trap was used in each site. Each trap included yellow colored sticky rectangular board, baited with a male sex lure (Spiroketal pheromone capsule) which was hanged inside the trap. The upper side of the board was painted with adhesive paste (Rinifoot), (Polisobutene 80% PA).

The trapped olive fruit flies were weekly counted (males are attracted to the trap by the pheromone action while females are attracted to the trap by the yellow color action) and sexed to males or females. The sticky boards were weekly replaced, and stored in the laboratory. However, the sex-pheromone lures were monthly replaced.

**Statistical Analysis:**

Statistical analysis was done using Minitab Analysis Program, taking in consideration that the 1st experiment includes four treatments (color traps) distributed randomly in three replications (sites). Thus, the design of the experiment is Completely Randomly Block Design.

## RESULTS

Effect of color on the attracting efficiency of sticky traps used for monitoring the flight activity of B. oleae:

Results presented in Table (1) show the means of the total olive fruit flies (of both sexes) that were captured/ sticky trap during the experiment. The sum of 182 flies was trapped/yellow trap; 64.7/green trap; 3.33 fly/blue trap and 0.67 fly/red trap.

**Seasonal flight activity of olive fruit fly, *B. oleae* in Bethlehem area during 2011and 2012:**

The results in Fig (1) show the flight activity of *B. oleae* recorded by the Jackson pheromone sticky traps in Battir, Hindaza, and, Tuqu' villages during 2011 season. It was found that *B. oleae* started its seasonal flight

activity in Battir, Hindaza and Tuqu' sites at the beginning of July, 2011, and then continued until late of November in Battir and Hindaza, and up to early January in Tuqu'.

Results also showed that olive fruit fly had three generations in Battir, Hindaza, and Tuqu'. In Battir, results presented in Fig (1-A) showed that the peak of 1st generation recorded about 12 flies/trap/week at the beginning of August; the second generation recorded in early September and the peak of the third generation recorded in late October, 2011.

However, in Hindaza site, results presented in Fig (1-B) show that the peak of the 1st generation with 12 flies/trap/week was recorded in mid August; then the peak of the 2nd generation with 129 flies/trap/week was recorded in early October and the peak of the 3rd generation with 99 flies/trap/week was recorded in mid-November, 2011. But, in Tuqu' site, results presented in Fig (1-C) show that the peak of the 1st generation with about 5 flies/trap/week was recorded in mid-August, the peak of the 2nd generation with 126 flies/trap/week was recorded in early November and as for the peak of the 3rd generation, 54 flies/trap/week was recorded in early December, 2011.

Furthermore, the results in Fig (2) summarized the flight activity of *B. oleae* in the three sites of Bethlehem, and showed that the seasonal flight activity was affected by temperature as well as rainfall, and thus, no flight activity observed at temperature ≤ 10°C or ≥ 30°C, and, very low flight activity was recorded during the rainy periods.

In addition, results presented in Fig. (1) showed that, the average numbers of *B. oleae* males that were weekly captured on sticky pheromone traps in Battir site were lower than that in Hindaza and Tuqu' throughout the season.

Results showed that few adults were caught/trap from early January up to early July and, the greatest numbers of flies were captured between late September and mid-December. At this time, the captured males ranged from 90 to 130/pheromone trap/week. However, in Tuqu' the flight activity continued until the end of January of the following year (2012), while the environmental condition were suitable for the flight of *B. oleae* in this site.

**Seasonal flight activity of *B. oleae* in Hindaza village for two successive growing seasons (2011-2012):**

Results obtained during 2011 season show that the numbers of *B. oleae* that were captured on pheromone sticky traps in Hindaza site were significantly higher than that in either Battir or Tuqu' sites. And, therefore, the experiment was continued in Hindaza for the second growing season 2012.

Results in Fig (3) show that in Hindaza site, *B. oleae* started its flight activity in early July, and, continued its activity throughout the season until the late of November during 2011. While during 2012, the flight activity started in early July, and continued its activity throughout the season up to late November.

Three generations of *B. oleae* were annually recorded in Hindaza site Fig (3) throughout the two years (2011 and 2012). In 2011, the peaks of the three generations were recorded on mid of August; early October and in mid of November respectively, meanwhile in 2012, the three generations were respectively recorded in mid of September; in last October, and in the mid November.

## DISCUSSION

Throughout the two successive years (2011-2012), the highest numbers were caught between late September and early November, and, few adults were caught by the traps between early of December, 2011 till late of July of the second year (2012). Thus, results show that the seasonal flight activity was affected by temperature as well as rainfall, and thus no flight activity recorded at temperature ≤ 10°C and the number of captured males\pheromone trap was observed to increase with increasing temperature from 20-25°C. In addition, very low flight activity was recorded during the rainy periods.

Results of the present study showed that throughout two

years of study (2011and 2012), the seasonal flight activity of *B. oleae* started in early July, and continued its activity throughout the season till the mid of November during 2011. While during 2012, the flight activity also started in early July, and continued its activity up to late November.

Present results also demonstrated three peaks of *B. oleae* flight activity were annually recorded throughout the two years (2011and 2012), and those peaks were also recorded on August-September; October and finally in mid of November. In addition, the population of *B. oleae* was very high in the second peak of flight activity which coincides the repining period of olive fruits and before the harvesting.

Those results are similar to that concluded by Al-Zaghal, (1985), in Jordan, who also reported three generations, the first with a peak that appeared in late July, the second with a peak which appeared in early October and the third appeared near the end of October. Furthermore, In Syria, Lebanon, the olive fruit fly had 4-5 generations yearly depending on local conditions (Avidov and Harpaz, 1969; Vossen and Devarenne , 2006).

Furthermore, the present study noted the relationship between flight activities of *B. oleae* and the climatic conditions including temperature as well as humidity and rainfall, and thus, flight activity declines at temperature ≤ 10°C or ≥ 30°C, and the number of captured males/pheromone traps were observed to be highest at temperature range from 20-25°C. In addition, very low flight activity was recorded during the rainy periods. Thus, results of the present study were in agreement with those found by Rice et al. (2003), they reported that the flight activity of adult *B. oleae* was mainly depended on temperature, fruit availability and seasonal phonology, and their attraction to yellow-panel sticky traps. In addition, Rice et al. (2003), found that also in the south California coast, flight activity declined as maximum daily temperatures rose above 32°C, but, it increased when temperatures were between 21°C and 28°C.

Economopoulos et al. (1982) also reported that in Greece, when average temperature was below 9°C, the olive fly did not show flight activity; also, as temperatures surpass 29°C, adult flies become increasingly agitated and above 35°C they become motionless (Johnson et al., 2011).

This research confirmed that throughout the season, the sticky yellow traps were more efficient in capturing *B. oleae* than the green sticky traps, but, both red and blue traps rarely captured olive fruit flies.

According to other workers, yellow sticky trap was found to attract the fly more than orange, red, green, black, and white color trap (Neuenshwander and Michelakis, 1978). In addition, Katsoyannos and Kouloussis, (2001), reported that the yellow and orange spheres trapped the greatest number of males of *B. oleae*.

**CONCLUSIONS**

- It's concluded that yellow color was the most significantly than any other colors investigated in this experiment.

- Flight activity of olive fruit fly was found to start at early July and continued until the end of November in Bethlehem area. *B. oleae* had three generations: the first generation was in August-September, the second one was in October and the third one was in mid-November.

- The climate changes (temperature and humidity) determined the beginning of the flight activity.

**RECOMMENDATIONS**

It is recommended to use Mass-Trapping Technique from the beginning of the flight activity starting from early July till end of November

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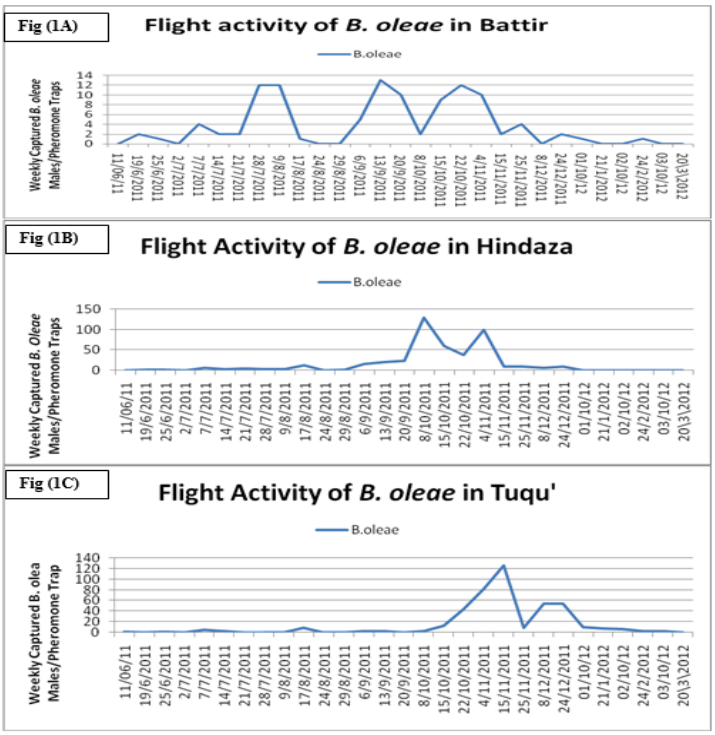


**Fig 1: Flight activity of *B. oleae* in Bethlehem area during 2011 season using Jackson pheromone sticky traps (A: Battir, B: Hindaza, and C: Tuqu').**

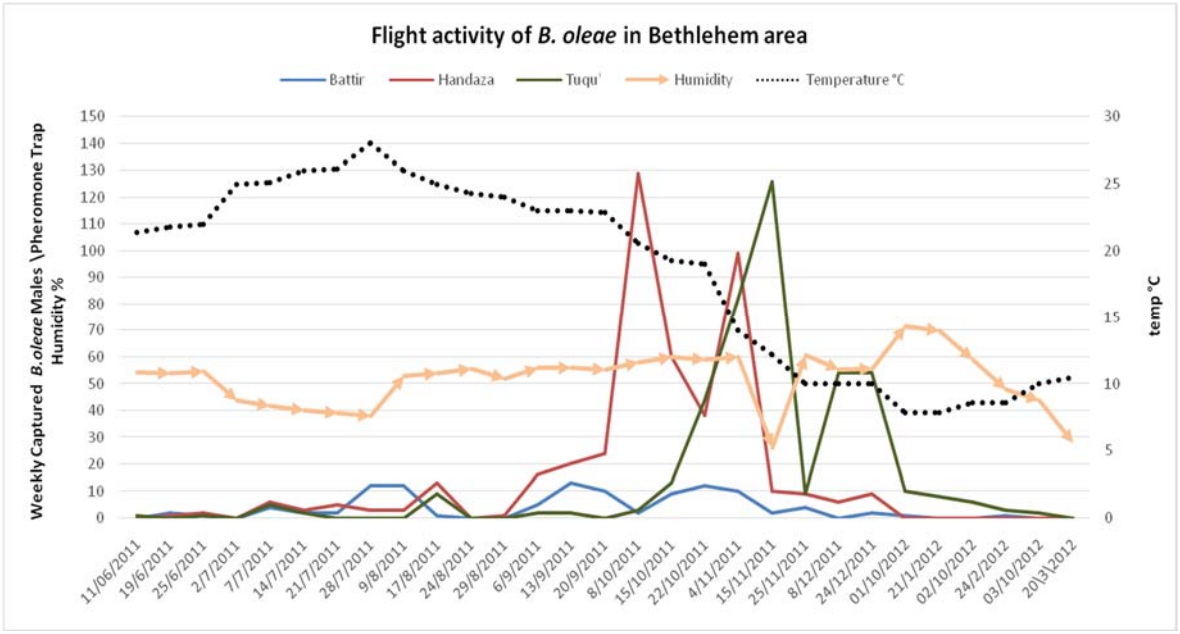


**Fig 2: Flight activity of *B. oleae* in three sites in Bethlehem area during 2011.**

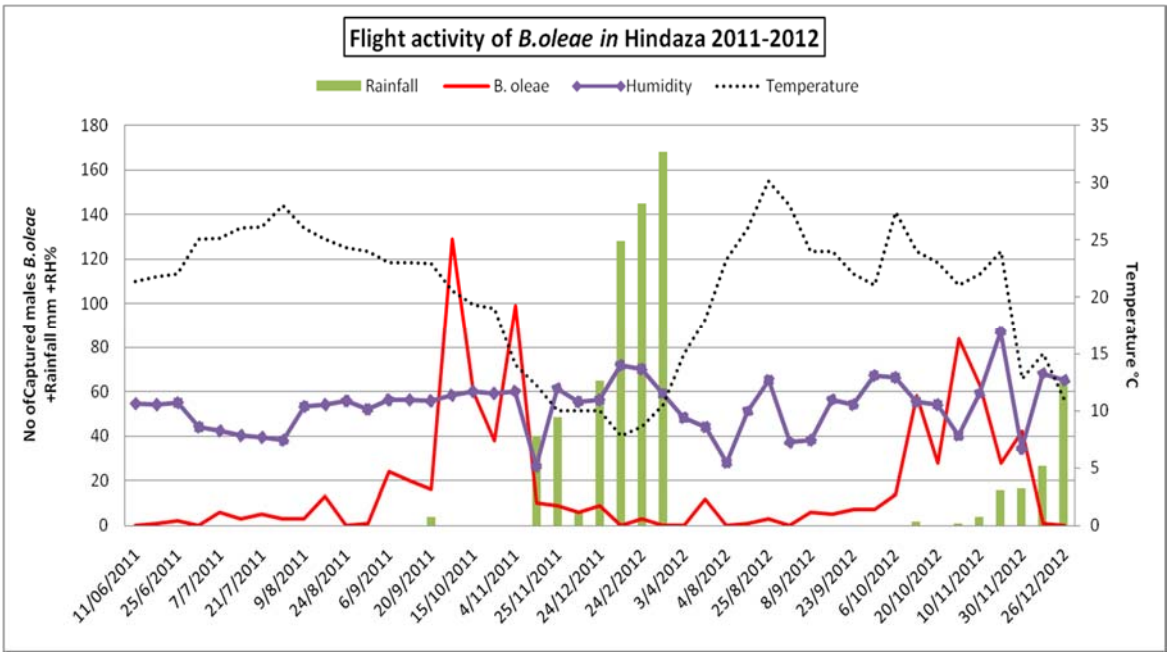


**Fig 3: Flight activity of *B. oleae* in Hindaza site during 2011 and2012.**

**Table 1. Means of total olive fruit flies that were trapped by various colored sticky traps. Mean* ± S.E**

| Mean | Yellow | Green | Red | Blue |
|---|---|---|---|---|
| Males | 139.0a±100 | 46.7ab±20.5 | 0.33b±0.33 | 1.67b±0.88 |
| Females | 42.7a±25.10 | 18.0a±5.13 | 0.33b±0.33 | 1.67b±1.67 |
| M + F | 182.0a±125.0 | 64.7a±25.2 | 0.67a±0.33 | 3.33b±2.40 |

*: Means within the same row with different letters significantly differ at P value ≤0.05 (Using Fisher's pairwise comparisons).

# رصد نشاط الطيران الموسمي لذبابة ثمار الزيتون[Bactrocera oleae (Gmelin) [Diptera: Tephritidae في المناطق الجبلية في وسط الضفة الغربية في فلسطين

***عبد الجليل حمدان* و محمد القرنة****

## ملخص

تعد أشجار الزيتون (*Olea europaea* L.) من أهم الأشجار المثمرة في فلسطين وتعد ذبابة ثمار الزيتون *Bactrocera oleae* أهم الآفات الحشرية التي تهاجمها بمنطقة حوض البحر الأبيض المتوسط بما فيها فلسطين. تم تنفيذ هذه الدراسة في منطقة بيت لحم وشملت الدراسة على صنفين من أشجار الزيتون هما النبالي والبلدي خلال موسمي 2011 و 2012. دلت البيانات المتحصل عليها ان نشاط طيران حشرة ذبابة ثمار الزيتون قد بدأ في بداية شهر تموز واستمر حتى نهاية شهر تشرين ثاني مسجلا ثلاث قمم لنشاط طيران الحشرة. فقد سجلت القمة الأولى خلال شهري آب وأيلول، كما سجلت القمة الثانية في شهر تشرين أول والقمة الثالثة في منتصف شهر تشرين ثاني. وقد تأثر حركة نشاط الطيران للحشرة بصفة اساسية بدرجة الحرارة و الرطوبة النسبية. وأنعكس ذلك على بداية نشاط الطيران وعدد أجيال الحشرة. ومن ناحية أخرى فقد أكدت النتائج المتحصل عليها أن المصائد اللاصقة الصفراء كانت الأعلى فعالية في جذب وصيد ذبابة ثمار الزيتون مقارنة مع المصائد الخضراء في حين ان فاعلية كل من المصائد الحمراء والزرقاء كانت متدنية في رصد نشاط طيران ذبابة ثمار الزيتون.

**الكلمات الدالة:** ذبابة ثمار الزيتون، *Bactrocera oleae* ، نشاط طيران، فلسطين.

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