

# Co-Existence of *Bactrocera dorsalis* Hendel (Diptera: Tephritidae) and *Ceratitis cosyra* Walker (Diptera: Tephritidae) in the Mango Orchards in Western Burkina Faso

Issaka Zida<sup>1</sup>, Souleymane Nacro<sup>2\*</sup>, Rémy Dabiré<sup>1</sup>, Irénée Somda<sup>3</sup>

<sup>1</sup>Institut de l'Environnement et de Recherches Agricoles, Station de Farako-bâ, Bobo Dioulasso, Burkina Faso

<sup>2</sup>Institut de l'Environnement et de Recherches Agricoles, Station de Kamboinsé, Ouagadougou, Burkina Faso

<sup>3</sup>Université Nazi Boni, Bobo Dioulasso, Burkina Faso

Email: \*snacro2006@yahoo.fr

**How to cite this paper:** Zida, I., Nacro, S., Dabiré, R. and Somda, I. (2020) Co-Existence of *Bactrocera dorsalis* Hendel (Diptera: Tephritidae) and *Ceratitis cosyra* Walker (Diptera: Tephritidae) in the Mango Orchards in Western Burkina Faso. *Advances in Entomology*, 8, 46-55.  
<https://doi.org/10.4236/ae.2020.81004>

**Received:** November 15, 2019

**Accepted:** December 9, 2019

**Published:** December 12, 2019

Copyright © 2020 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).  
<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

Fruit flies (Diptera: Tephritidae) are one of the insect groups that menace the horticultural sector in sub Saharan Africa. The main fruit fly species that caused mango fruits (*Mangifera indica* L.) damage in Western Burkina Faso include *Bactrocera dorsalis* Hendel and *Ceratitis cosyra* Walker. This work was carried out in Western Burkina Faso to study the relationships between these two insect pests on mango fruits in mango orchards. Thirty mango fruits per variety were sampled in six mango orchards every two weeks during two consecutive mango seasons (2017 and 2018). Each mango fruit was incubated individually for the emergence of adult fruit flies. *Bactrocera dorsalis* accounted for 66.30% of fruit flies reared from mango fruits and *C. cosyra* was represented by 33.52% of adult flies. Among mango fruits infested by fruit flies, 53.50% were attacked only by *B. dorsalis*, 22.14% by *C. cosyra* and 20.35% were infested by both species. In the mango fruits co-infested, 54.03% of adults belonged to *B. dorsalis* and 45.96% of adults were individuals of the *C. cosyra* species. The infestation rates of *C. cosyra* were higher at the beginning of the mango season while those of *B. dorsalis* were zero, and vice-versa at the end of mango season. This study highlights the relatively stable co-existence between these two major insect pests of mango fruits in mango orchards in Western Burkina Faso.

## Keywords

Mango, *Bactrocera dorsalis*, *Ceratitis cosyra*, Co-Infestation, Infestation Index

## 1. Introduction

Fruit flies (Diptera: Tephritidae) pose a serious threat to the horticultural sector in sub-Saharan Africa. In Burkina Faso, mango is the cultivated fruit that is the most affected by these insect pests. *Ceratitis cosyra* (Walker) has long been recognized as the most damaging tephritid fruit fly pest of mango fruits (*Mangifera indica* L.) in Africa [1]. The damage of fruit flies on mango worsened following the introduction of *Bactrocera dorsalis* Hendel (ex. *Bactrocera invadens*), a highly polyphagous species that attacks both cultivated and wild fruits. In Western Burkina Faso, [2] reported the existence of seven fruit fly species in mango orchards. Among them, two fruit fly species, *B. dorsalis* detected for the first time in 2005 in Burkina Faso and *C. cosyra* represented about 95% of the total catches [2]. These two fruit fly species were responsible for about 96% of the damage on mango fruits [3]. The introduction and successful adaptation of a species out of its natural range of distribution produce drastic changes in the abundance and distribution of species [4] [5]. Invasive species can modify native biodiversity, shaping new interspecific interactions either directly or indirectly. Interspecific competition is among the most common interactions induced after a biological invasion, at least for insect species [6]. Several studies have shown that *B. dorsalis* has a high potential to displace some native species from their spawning site as well as their natural geographic range [7] [8]. [7] indicated the rapid displacement of *C. cosyra* by *B. dorsalis* at Nguruman, Kenya, 4 years after its detection in the African continent. This study aims to deepen knowledge on the bio-ecology of *B. dorsalis* 14 years after its detection in order to improve control methods. Specifically, it was about studying the interspecific competition between the introduced and invasive species, *B. dorsalis* and the native one, *C. cosyra* in mango orchards in Western Burkina Faso.

## 2. Materials and Methods

### 2.1. Study Sites

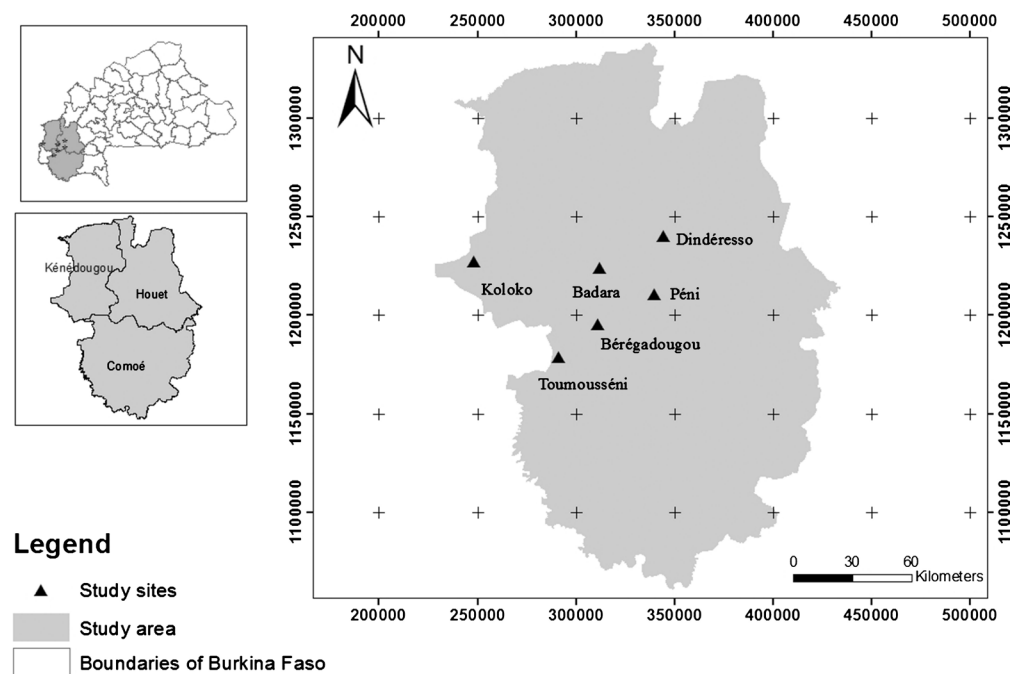
This study was carried out in six mango orchards of two regions in Western Burkina Faso. The selected sites in the two-targeted regions included Dindéresso and Péni (Houet province), Badara and Koloko (Kénédougou province), Bérégadougou and Toumousséni (Comoé province). **Figure 1** presents the localization of the study sites. This area is the major fruit-producing zone in Burkina Faso. It belongs to the South-sudanian climatic zone and is characterized by an annual average rainfall between 900 and 1200 mm with monthly average temperatures rarely exceeding 35°C.

**Figure 2** shows the average monthly rainfall of the study area during the study period.

### 2.2. Methods

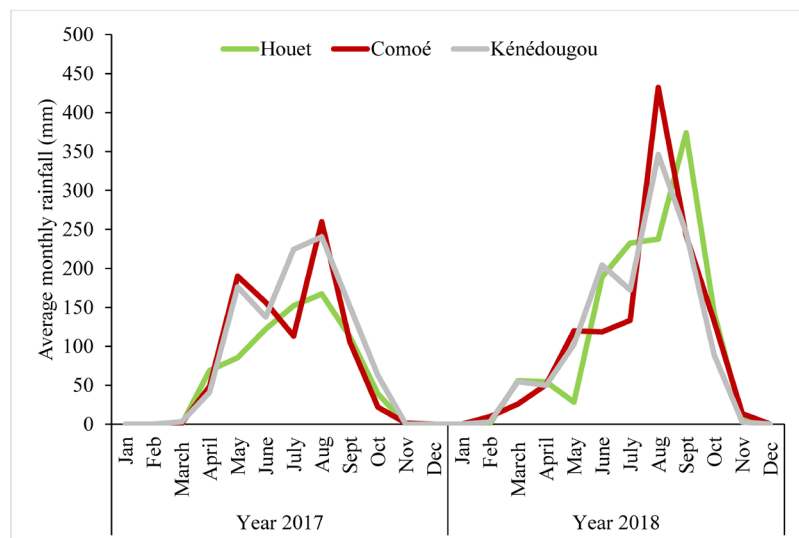
#### 2.2.1. Sampling

Samples of mango fruits at physiological maturity were randomly collected from



Source: BNDT (2012) and Field data

**Figure 1.** Localization of the study sites.



**Figure 2.** Average monthly rainfall in the three provinces during the study period.

mango trees in six mango orchards. Thirty mango fruits per variety and per orchard were collected every two weeks during the mango period for two consecutive seasons (2017 and 2018). Each sample of mango fruits was packaged in labeled jute bags. On each label, the following information was mentioned: name of the site, name of the variety and collection date.

### 2.2.2. Mango Fruits Incubation

Each mango fruit was weighed and placed individually in 1.5 liter plastic box (diameter: 25 cm; height: 12 cm) containing sieved and sterilized sand, which

was used by larvae as a pupation substrate after leaving the fruit. Each container had a lid to avoid other insects from contaminating the sample.

### 2.2.3. Handling of Insects

Each rearing box was checked every five days. Each fruit was observed and those that have been infested with fruit fly larvae were counted. The sand was sifted for the presence or absence of tephritid puparia, which were picked up using a pair of soft forceps or by gently sifting. These were counted before being placed in labelled petri dishes (94 mm × 15 mm) with moistened filter paper. Petri dishes containing the pupae were placed in rectangular cages (15 cm × 15 cm × 20 cm) stored in a breeding room with the following facilities: temperature:  $25^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ; relative humidity:  $65\% \pm 2\%$ . The pupae were held in the rearing cages until the total emergence of insects. Emerged adults were collected when full body coloration was reached and stored in pillboxes containing ethanol diluted to 70%.

### 2.2.4. Fruit fly Species Identification

Fruit fly adults were identified with published identification keys. *Bactrocera dorsalis* samples were identified using physical key [9] while other fruit fly species were identified to either genus or species level using an electronic key [10]. The number of individuals of each fruit fly species was recorded in a data sheet per variety according to the collection date.

### 2.2.5. Data Handling and Analysis

An exact count of the number of infested mango fruits, the number of pupae and the number of adult insects coming from each variety and from each site was carried out at each collection date. The variables evaluated were: 1) percentage of infested fruits (without distinction between fruit fly species) per variety and collection dates; 2) percentage of fruits infested by *C. cosyra*; 3) percentage of fruits infested by *B. dorsalis*; 4) percentage of co-infested fruits (fruits simultaneously infested by both species); 5) number of adults of *B. dorsalis* per kg of fruit (infestation rate); 6) number of adults of *C. cosyra* per kg of fruit.

Excel 2013 from Microsoft's Office 2013 was used for data capture and preparation of the various graphics. Statistical analysis of the data was performed using Statistica 7.1 program. The statistical analysis was based on an analysis of variance (ANOVA) followed by a Student Newman-Keuls test using a probability threshold of 5%.

## 3. Results

### 3.1. Species Diversity of Mango Fruit-Infesting Fruit Flies

A total of 4502 mango fruits belonging to the varieties Amelie, Mango vert, Sabre (early-varieties), Kent, Lippens, Smith, Valencia (intermediate-varieties), Brooks, Keitt (late-varieties) with a weight of 1384.51 kg were collected and incubated for the emergence of insects. We obtained the emergence of 18,521 adult fruit flies from the 23,797 pupae, representing an overall emergence rate of

77.82%. The fruit fly species associated with mango fruits in order of numerical importance were: *Bactrocera dorsalis* Hendel represented by 12,280 individuals (66.30% of emergences); *Ceratitis cosyra* Walker with 6209 individuals (33.52%); *Ceratitis silvestrii* Bezzi represented by 15 individuals; *Ceratitis quinaria* Bezzi (11 individuals) and *Ceratitis fasciventris* Bezzi (6 individuals). The *B. dorsalis* and *C. cosyra* species accounted for 99.82% of the fruit fly adults emerged from the mango fruits during the current study.

### 3.2. Evolution of the Average Attack Rates of Mango Fruits during the Study Period

**Table 1** presents the average attack rates of mango fruits by fruit fly species. It can be seen that the rate of damaged fruits depended on the collection dates as well as on the variety considered (**Table 1**). The attacks were very low at the beginning of the mango season, but they became higher at the end of the season according to the variety considered. Indeed, the average attack rates ranged from 0 to 0.43% at the beginning of the season (early April) and from 20.65% to 86.67% at the end of the season (early July) depending on the variety.

Analysis of variance revealed highly significant differences in average attack rates between mango varieties ( $F = 6.04$  and  $P < 0.000$ ) on one hand and between collection dates ( $F = 69$ , and  $P < 0.000$ ) on the other hand.

### 3.3. Co-Infestation of Mango Fruits by Fruit Fly Species

A total of 727 mango fruits were attacked by fruit flies. The results showed that 53.50% were infested only by *B. dorsalis*, 22.14% only by *C. cosyra*, 20.35% were infested by both species and 3.98% infested by other fruit fly species. In the co-infested mango fruits, 3274 fruit fly adults were emerged, of which 54.03% belonged to *B. dorsalis* and 45.96% adults were for *C. cosyra*.

### 3.4. Evolution of Infestation Rates of *B. dorsalis* and *C. cosyra* on Mango Fruits during the Study Period

#### 3.4.1. According to the Sampling Dates

**Figure 3** shows the evolution of the average number of adults of *B. dorsalis* and

**Table 1.** Average attack rates of the mango fruits according to the varieties and collection dates.

Collection dates	Varieties								
	Amélie	Brooks	Keitt	Kent	Lippens	Mango vert	Sabre	Smith	Valencia
14-Apr.	0	0	0	0.43 ± 0.09	0.06 ± 0.04	0	0	0	0
28-Apr.	0	0.30 ± 0.08	-	0.10 ± 0.03	0	0.03 ± 0.001	0	0.06 ± 0.04	0
14-May	0.02 ± 0.02	3.99 ± 1.85	2.08 ± 1.78	0.36 ± 0.15	1.61 ± 1.02	0	0.03 ± 0.03	0.18 ± 0.18	0.18 ± 0.04
28-May	0	6.00 ± 2.00	0.04 ± 0.02	4.85 ± 1.72	2.69 ± 1.87	0	0	0.34 ± 0.26	0.21 ± 0.04
14-June	0	6.88 ± 1.83	4.80 ± 1.69	13.54 ± 3.55	3.65 ± 1.79	-	-	2.90 ± 1.84	8.21 ± 3.54
28-June	12.50 ± 8.53	18.17 ± 2.76	18.8 ± 0.93	23.00 ± 0.07	0.03 ± 0.03	-	-	16.15 ± 5.34	40.00 ± 12.24
14-July	-	20.65 ± 5.04	28.47 ± 3.83	86.67 ± 9.08	-	-	-	-	-

*C. cosyra* per kg of fruit during the two consecutive mango seasons (2017 and 2018). The infestation rates of both fruit fly species evolved inversely. Indeed, the infestation rate of mango fruits by the species *B. dorsalis* was zero at the beginning of the mango season and then evolved gradually until the end of the season while the average number of individuals of *C. cosyra* per kg per fruit decreased as the mango season draws to a close.

### 3.4.2. According to the Study Sites

Figure 4 shows the infestation rates of mango fruits according to the study site.

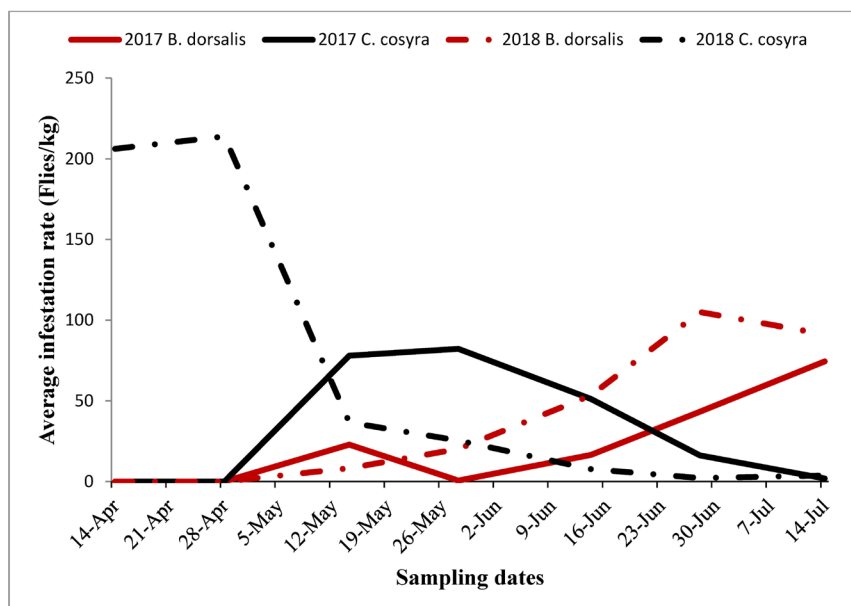
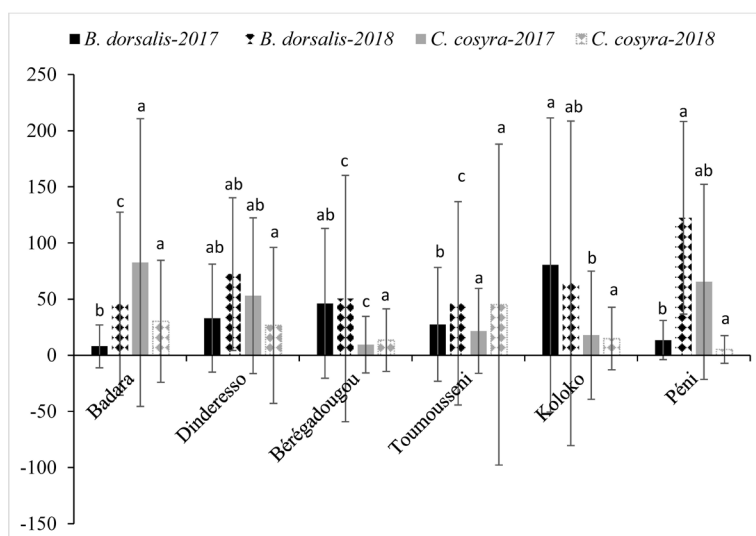


Figure 3. Average infestation rates of mango fruits by *B. dorsalis* and *C. cosyra* according to the sampling dates.



N.B. vertical bars followed by the same letter are not significantly different at 5% probability.

Figure 4. Average infestation rates of *B. dorsalis* and *C. cosyra* on mango fruits according to the study sites.

From this, it can be seen that the average infestation rates of fruits varied depending on the study sites. During the mango season 2017, the mango orchards of Koloko and Bérégaougou recorded the highest infestation rates of *B. dorsalis* ( $80.45 \pm 131.08$  and  $46.20 \pm 66.66$  flies per kg) and the lowest infestation rates of *C. cosyra* (respectively  $17.84 \pm 57.03$  and  $9.51 \pm 25.27$  flies per kg).

During the mango season 2018, the mango orchards of Péni recorded the highest infestation rate of *B. dorsalis* ( $122.49 \pm 144.61$  flies per kg of fruit) and the lowest infestation rate of *C. cosyra* ( $5.17 \pm 12.41$  flies/kg).

We observed that, in general, the mango orchard that recorded the highest density of adults *B. dorsalis* recorded at the same time the lowest density of adults of *C. cosyra*.

#### 4. Discussion

Five fruit fly species emerged from mango fruits during the two consecutive mango seasons (2017 and 2018), of which *B. dorsalis* and *C. cosyra* accounted for 99.82% of emerged adults. However, [3] reported that seven fruit fly species of Tephritidae were associated with mango fruits in the same study area. This result could be explained by a probable displacement of certain fruit fly species of the genus *Ceratitis* by the invasive *B. dorsalis*. Average attack rates varied significantly between collection dates on one hand and between varieties on the other hand. On April 14, only the varieties Kent and Lippens were attacked by fruit flies with average attack rates of  $0.43 \pm 0.09$  and  $0.06 \pm 0.04$ , respectively. We observed that mango fruit infestations by fruit flies became more and more important as the campaign progressed. Thus, the highest average attack rates were recorded at the end of the mango season (late June to mid-July). Depending on the mango varieties, we observed that local cultivars were very lowly or not attacked. This situation could be explained by the fact that agronomists have only considered yield and fruit taste criteria during the breeding process, while local varieties that are well adapted to their environment are under less pressure of insect pests.

Among the improved varieties, Amélie and Lippens (early and mid-cultivars) recorded the lowest attack rates in the current study while the late one, Keitt and Brooks suffered the most attacks of fruit flies. This result could be explained by the fact that at the end of the mango season, these varieties constitute the only breeding sites favorable to a period which coincided with the implosion of the populations of *B. dorsalis* in the mango orchards [2]. During this study, several mango fruits were infested by both species (*B. dorsalis* and *C. cosyra*). Recent studies have reported the co-infestation of guava (*Psidium guajava*) with an introduced species *Bactrocera carambolae* and native species of the genus *Anastrepha* in Brazil [11] and *Ceratitis capitata* (introduced species) and *Anastrepha fraterculus* (native species) in Argentina [8] [12].

In the current study, the results showed that *B. dorsalis* and *C. cosyra* were responsible for respectively 66.30% and 33.52% of damage recorded on mango



fruits. [3] stated that during the mango seasons 2008 and 2009, *B. dorsalis* was responsible for almost 65% of the damage while *C. cosyra* was responsible for about 30% of the damage observed on mango fruits in the same study area. Thus, it appears that there is a relatively stable coexistence between these two fruit fly species in mango orchards in Western Burkina Faso. The study of the evolution of the density of the two main species responsible for mango fruit damage during the two seasons revealed that the number of adults per kg per fruit of *C. cosyra* was higher during the early mango season (April-May) at the end of the dry season. In contrast, the highest infestation rates of *B. dorsalis* were recorded at the end of the mango season during the wet season. In addition, our findings revealed that the mango orchards with the highest infestation rates of *B. dorsalis* recorded at the same time the lowest infestation rates of *C. cosyra* and vice versa. In fact, some mango orchards consist mainly of early varieties mainly attacked by *C. cosyra* while others are home to mid and late varieties mainly by *B. dorsalis*.

The main factors that facilitate the co-existence in mango orchards of these insect pests are the climatic factors such as rainfall and temperatures and the availability of fruit hosts. *Ceratitis cosyra* is most abundant during the dry season when temperatures were high and its population level decline with the first rains [13]. In contrast, *B. dorsalis* population level was very low during the dry period when no rainfall was recorded, but increased steadily from the start of the rains. Also, in our study area, the mango fruiting season is spread over 4 to 5 months. There are therefore early mango cultivars which were infested with *C. cosyra* during the dry period and the mid and late varieties which were infested with *B. dorsalis*. Previous studies indicated that *C. cosyra* caused damage on early mango cultivars in Burkina Faso [2] and Benin [13]. [13] reported that *B. invadens* is involved in the majority of mango damage after the first rains in this area. In fact, *B. dorsalis* caused more than 90% of the damage on mid- and late mango cultivars in both Southern Sudan and Northern Sudan zones [14] [15]. In the Sahelian zone (in Senegal-Niayes), *Bactrocera dorsalis* was considered to be the main insect pest associated with mango fruits during the rainy season [16] [17] [18]. In case of strong pressure, *C. cosyra* move on indigenous fruit hosts present in plant formations surrounding the mango orchards to avoid competition. According to [19], *C. cosyra* found from May to July suitable fruit hosts such as *Annona senegalensis* Pers., *Sarcocephalus latifolius* (Sm.) E.A.Bruce, *Saba senegalensis* A. DC., *Sclerocarya birrea* (A. Rich.) Hochst in the plant formations around mango orchards.

In the co-infested mango fruits, 54.03% fruit fly adults emerged belonged to *B. dorsalis* and 45.96% adults were *C. cosyra*. [7] reported that the high reproductive capability of *B. invadens* allows it to achieve enormous population size. [20] stated that a female *B. dorsalis* has a fecundity rate of 1056.8 eggs as against 356 eggs for *C. cosyra*. Over time, the numerical advantage of *B. dorsalis* may reduce the probability of *C. cosyra* individuals to have access to available re-



sources. According to [7], in under interspecific competition, larval duration in *B. dorsalis* was significantly shorter ( $6.2 \pm 0.6 - 7.3 \pm 0.3$  d) as compared with *C. cosyra* ( $8.0 \pm 1.2 - 9.4 \pm 0.4$  d).

## Acknowledgements

Authors are grateful to the technicians Sow Adama and Soubeiga Marcel for their assistance in collecting the data as well as in breeding fruit flies in the laboratory. This work was financially supported by the Regional Plan for the Control of fruit flies in West Africa.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

- [1] Lux, S.A., Copeland, R.S., White, I.M., Manrakhan, A. and Billah, M. (2003) A New Invasive Fruit Fly Species from the *Bactrocera dorsalis* (Hendel) Group Detected in East Africa. *International Journal of Tropical Insect Science*, **23**, 355-361.
- [2] Ouédraogo, S.N., Vayssières, J.-F., Dabiré, A.R. and Rouland-Lefèvre, C. (2011) Biodiversity of Fruit Flies in Mango Orchards in Western Burkina Faso: Structure and Comparison of Communities in Different Localities. *Fruits*, **66**, 393-404. <https://doi.org/10.1051/fruits/2011054>
- [3] Ouédraogo, S.N. (2011) Spatio-Temporal Dynamics of Fruit Flies (Diptera Tephritidae) According to Biotic and Abiotic Factors in Mango Orchards in Western Burkina Faso. PhD Thesis, Estern, Paris.
- [4] Williamson, M. (1996) Biological Invasions. Chapman & Hall, London, UK.
- [5] Juliano, S.A. and Lounibos, L.P. (2005) Ecology of Invasive Mosquitoes: Effects on Resident Species and on Human Health. *Ecology Letters*, **8**, 558-574. <https://doi.org/10.1111/j.1461-0248.2005.00755.x>
- [6] Kenis, M., Auger-Rozenberg, M.A., Roques, A., Tims, L., Péré, C., Cook, M.J.W., Settele, J., Augustin, S. and Lopez-Vaamonde, C. (2009) Ecological Effects of Invasive Alien Insects. *Biological Invasions*, **11**, 21-45. <https://doi.org/10.1007/s10530-008-9318-y>
- [7] Ekesi, S., Billah, M.K., Nderitu, P.W., Lux, S.A. and Rwomushana, I. (2009) Evidence for Competitive Displacement of *Ceratitis cosyra* by the Invasive Fruit Fly *Bactrocera invadens* (Diptera:Tephritidae) on Mango and Mechanisms Contributing to the Displacement. *Journal of Economic Entomology*, **102**, 981-991. <https://doi.org/10.1603/029.102.0317>
- [8] Liendo, F.C., Parreno, M.A., Cladera, J.L., Vera, M.T. and Segura, D.F. (2018) Coexistence between Two Fruit Fly Species Is Supported by the Different Strength of Intra- and Interspecific Competition. *Ecological Entomology*, **43**, 294-303. <https://doi.org/10.1111/een.12501>
- [9] White, I.M. (2006) Taxonomy of the Dacina (Diptera: Tephritidae) of Africa and the Middle East. *African Entomology*, **2**, 1-156.
- [10] Virgilio, M., White, I.M. and De Meyer, M. (2014) A Set of Multi-Entry Identification Keys to African Frugivorous Flies (Diptera, Tephritidae). *ZooKeys*, **428**,

- 97-108. <https://doi.org/10.3897/zookeys.428.7366>
- [11] Deus, E.G., Godoy, W.A.C., Sousa, M.S.M., Lopes, G.N., Jesus-Barros, C.R., Silva, J.G. and Adaime, R. (2016) Co-Infestation and Spatial Distribution of *Bactrocera carambolae* and *Anastrepha* spp. (Diptera: Tephritidae) in Common Guava in the Eastern Amazon. *Journal of Insect Science*, **88**, 1-7. <https://doi.org/10.1093/jisesa/iew076>
- [12] Devescovi, F., Liendo, F.C., Bachmann, G.E., Bouvet, J.P., Milla, F.H., Vera, M.T., Cladera, J.L. and Segura, D.F. (2015) Fruit Infestation Patterns of *Anastrepha fraterculus* and *Ceratitis capitata* Reveal that Cross-Recognition Does Not Lead to Complete Avoidance of Interspecific Competition in Nature. *Agricultural and Forest Entomology*, **17**, 325-335. <https://doi.org/10.1111/afe.12111>
- [13] Vayssières, J.-F., Goergen, G., Lokossou, O., Dossa, P. and Akponon, C. (2005) A New *Bactrocera* Species Detected in Benin among Mango Fruit Flies (Diptera Tephritidae) species. *Fruits*, **60**, 371-377. <https://doi.org/10.1051/fruits:2005042>
- [14] Vayssières, J.-F., Korie, S., Coulibaly, O., Temple, L. and Boueyi, S. (2008) The Mango Tree in Northern Benin: Cultivar Inventory, Yield Assessment, Infested Stages and Loss Due to Fruit Flies (Diptera, Tephritidae). *Fruits*, **63**, 335-348. <https://doi.org/10.1051/fruits:2008035>
- [15] N'Guessan, E., Seri, P., Aboua, L., Kadio, E., N'Klo, H., Koua, H. and Vayssières, J.-F. (2011) Demographic Parameters of the Invasive Species *Bactrocera invadens* (Diptera Tephritidae) in Guinean Area of Côte d'Ivoire. *Asian Journal of Scientific Research*, **1**, 312-319.
- [16] Ndiaye, O., Vayssières, J.-F., Rey, J.-Y., Ndiaye, S., Diedhiou, P.M., Ba, C.T. and Diatta, P. (2012) Seasonality and the Importance of Fruit Fly (Diptera Tephritidae) Host Plants in Orchards at Niayes and the Thiès Plateau (Senegal). *Fruits*, **67**, 311-331. <https://doi.org/10.1051/fruits/2012024>
- [17] Vayssières, J.-F., Korie, S. and Ayegnon, D. (2009) Correlation of Fruit Fly (Diptera, Tephritidae) Infestation of Major Mango Cultivars in Borgou (Benin) with Abiotic and Biotic Factors and Assessment of Damages. *Crop Protection*, **28**, 477-488. <https://doi.org/10.1016/j.cropro.2009.01.010>
- [18] Vayssières, J.-F., Vannière, H., Gueye, P.S., Barry, O., Hanne, A.M., Korie, S., Niasy, A., Ndiaye, M. and Delhove, G. (2011) Preliminary Inventory of Fruit Fly Species (Diptera Tephritidae) in Mango Orchards in the Niayes Region, Senegal. *Fruits*, **66**, 91-107. <https://doi.org/10.1051/fruits/2011002>
- [19] Ouédraogo, S.N., Vayssières, J.-F., Dabiré, R.A. and Rouland-Lefèvre, C. (2010) Indigenous Fruits Host of Mango Fruit-Infesting Fruit Flies (Diptera: Tephritidae) in Western Burkina Faso: Identification and Infestation Rate. *Fruits*, **4**, 36-41.
- [20] Ekesi, S., Nderitu, P.W. and Rwomushana, I. (2006) Field Infestation, Life History and Demographic Parameters of the Fruit Fly *Bactrocera invadens* (Diptera: Tephritidae) in Africa. *Bulletin of Entomological Research*, **96**, 379-386.