Journal of Applied Biosciences 205: 21684 – 21692
ISSN 1997-5902

Preference of fruit flies toward three host plants (mango, shea, guava)

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Submission 12th October 2024. Published online at https://www.m.elewa.org/Journals/ on 31st January 2025 https://doi.org/10.35759/JABs.205.7

ABSTRACT

Objective: The study documented the preferences of two fly species toward some host plants. *Methodology and Results:* Fruits (mangoes, shea and, guavas) harvested in orchards were observed in the laboratory for about ten days. The healthy fruit served as nesting sites for fruit fly species under semi-natural conditions. Ovipositors were removed from the cages of *C. cosyra* and *B. dorsalis* 24 h after exposure and then incubated in cups until emergence. The results of rearing fruit flies in these three substrates in the laboratory revealed two fly species: *B. dorsalis and, C. cosyra*. They also showed a preference for *B. dorsalis* species over shea with an average of 78.22 flies, followed by guava with 24.8 flies. Mango is preferred by *C. cosyra* species as the host fruit with 19.72 flies. *B. dorsalis* species laid eggs in all three fruits. *Conclusion and Application of results:* These results can serve as a prerequisite for the identification and mass breading of beneficial insects effective against these fruit flies. Their release in orchards is a new control method that will considerably reduce fruit fly losses.

Keywords: Fruit flies, host fruits, integrated fight, orchards, Mali

INTRODUCTTION

The mango tree [*Mangifera indica* Anacardiaceae] is one of the most widely planted fruit trees in Asia, Africa and Mali in particular (Vayssières *et al.*, 2004). Its global production was estimated at more than 37 million tons (Asia, the continent of origin of mango, is the largest producer with 76.3% of world production followed by America with 12.3% and Africa with 11.4% (Strebelle, 2013). The mango tree occupies a primordial place in Malian arboriculture (Thiam *et al.*, 2001). Its fruit (mango), the most consumed in Mali, is a source of complete food in vitamin C as well as income for the rural population. Mango is produced throughout Mali, but the major production areas are located in the regions of Sikasso, Ségou, Koulikoro and the district of Bamako (Thiam *et al.*, 2001). In

these production areas, mainly in Koulikoro, the lack of technical assistance and rainfall are the major constraints identified. Traditional water sources, primitive watering methods and poor moisture conservation techniques are factors that increase the vulnerability of orchards to rainfall variability (Diarra *et al.*, 2021). These factors contributed to the decline in production. Thus, the quantities of mangoes produced from 2015 are: 66049.56 tons in 2015; 67315 tons in 2016; and, 64730 tons in 2017 (IFM, 2016, IFM, 2017). From 2018, the annual production has seen a slight increase. Production is estimated in 2018, 2019, and 2020 at 76,453 tons, 77,685 tons, and 79,7949 tons respectively . Despite this high production, the country exports an insignificant amount, 22,276 tons (2018), 31,277 tons (2019) and 22,011 tons (2020)(Jones *et al.*, 2005). Among the quantities exported, some containers of mangoes intercepted at European borders we quote in: 2014 (25); 2015 (11); 2016 (66); 2017 (25) (IFM, 2018) . and 2018 (26) (European Commission). The strategies put in place by the main actors of the sector had made it possible to considerably reduce the number of containers intercepted on the European market from 66 to only 6% of the volume exported in 2018. According to the Plant Protection Office of Mali, the number of seizures increased again in 2019 (16 containers intercepted). Damage to mangoes is generally due to pests, particularly fruit flies, despite the often uncontrolled use of chemical insecticides, with all that this entails for the environment. These flies belong to the Tephritidae family. They cause considerable economic losses for farmers (Vassyières *et al.*, 2014). The rate of infestation of mango varieties by flies has been the subject of work in the region (N'dépo *et al.*, 2009, Vassyières *et al.*, 2010, Gomina, 2015). The study by N'dépo *et al.*, (2009) showed that the mango varieties (Kent, Keitt and Amelie) are most often infested by the species *Bactrocera dorsalis*. Specific studies have been conducted on *Ceratitis* (Tephritidae) in Mali by Noussourou and Diarra (1995). In addition, inventories have been carried out in the peri-urban area of Bamako and in the Sikasso region (Noussourou et Diarra, 1995; Noussourou, 2001). Work on the rate of infestation was also carried out by Vayssière *et al.* (2010), who reported three varieties of mangoes most bitten by species of the genus *Ceratitis*. A study on the emergence of fruit flies from various mango varieties showed that *C. cosyra*, and *B. dorsalis* were the most dominant species. Fruit fly population dynamics and infestation rates in orchards in Kati documented by Assogba (2019) show the extent of damage caused by fruit flies during the mango season. It is therefore necessary to conduct a study on the preference of host plants (mango, shea and, guava) by fruit flies to strengthen control strategies.

MATERIALS AND METHOD

The investigations were conducted from April through August 2017 and 2018. Fruits (mango, shea and, guava) were collected from a 1.24 ha orchard in Kati (12°77′31″North and 8°12′00″West, in the soudanien zone of Mali).

Preparation and installation of the nesting boxes: Fruits harvested in the orchards were put under observation in the laboratory for about 10 days. Those that showed no evidence of fly bites or larval damage served as egg-laying sites for *C. cosyra*. Among these fruits, the ripe ones were pricked with an entomological needle (to facilitate oviposition of the gravid females) and placed on a toilet paper in a petri dish and finally exposed to *Ceratitis cosyra* adults. The work was carried out under semi-natural conditions (a screened shed designed for this purpose equipped with a thermo-hygrometer I.T.WORKS, Model N°: KW.9007, Kesa UK HU1 3AU, 433 MHZ).

The insectarium and cages are cleaned weekly to prevent the development of infections and the spread of unwanted insects such as ants and cockroaches.

Incubation : The ovipositors (fruits) were removed from the cages of *C. cosyra* 24 h after the exposure, placed in a plastic plate and then, the whole in a plastic bag containing sand allowing the L3 larvae to make the pupation. The bag was covered with muslin tulle to prevent the larvae from escaping.

Capture of *Ceratitis cosyra* adults: The capture of *C. cosyra* adults was done with a mouth aspirator as we went along.

Water trough deposits and adult feeding: The troughs were plastic bottles containing drinking water, closed by lids with a hole for a piece of absorbent cotton to pass through, the lower end of which dipped into the water, which rose by capillary action, thus serving as a drinking trough for insects. Adults of *Ceratitis cosyra* were fed Yeast Hydrolysate Enzymatic with the following proportions: one measure of Yeast Hydrolysate Enzymatic for three measures of sugar. A mixture of soybean flour and sugar in almost equal proportions has been tried as a food.Shea and guava used as nests underwent the same procedure.

Case of *Bactrocera dorsalis:* The same approach was adapted for the rearing of *B. dorsalis* at the Faculty of Sciences and Techniques (FST) Entomology laboratory.

Data analysis: The data were initially reported on the collection sheets, entered Excel and then analyzed using R software (R version 4.4.2, http://www.r-project.org). These analyses consisted of establishing a correlation between meteorological parameters and fly populations; simple descriptive statistics were calculated.

RESULTS

Emergence rate of pupae during rearing: Emergence rates for both species were calculated, and Figure 1 shows the levels for the two rearing years.

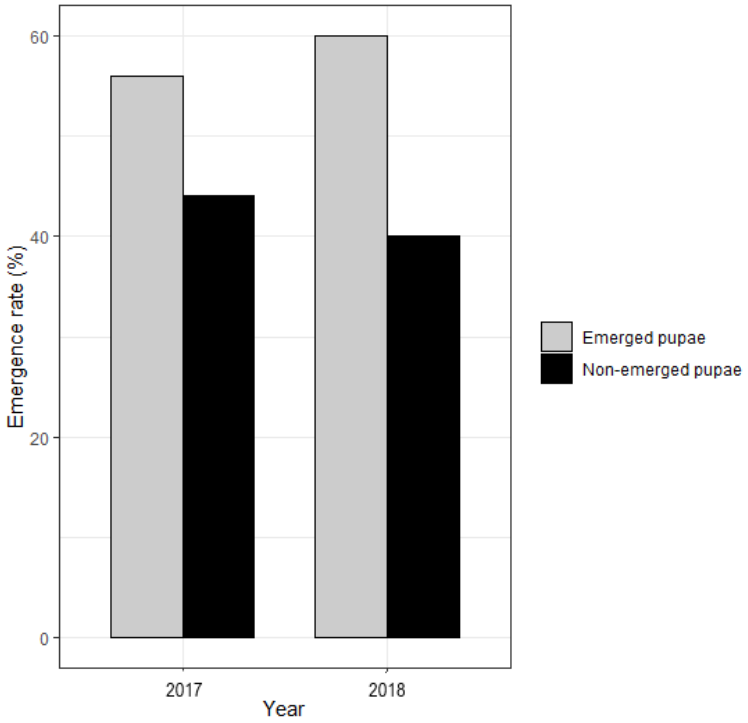

Figure 1. Emergence rate on the three types of fruits (mango, shea and, guava).

The pupal life span varied from 7 to 14 days in *C. cosyra* and from 7 to 12 days for *B. dorsalis* under our rearing conditions. Figure 1 shows that in 2017, 56% of pupae emerged compared to 60% in 2018 for all varieties combined.

Numbers of *B. dorsalis* and *C. cosyra* reared: The results of the rearing of fruit flies on these three different materials in the laboratory revealed the presence of two species: *B. dorsalis* and, *C. cosyra* (Table1).

Table 1. Difference on the average of fruit fly species in mango, shea and guava.

Species/Types of fruit	Mango	Shea	Guava
B. dorsalis	3,72a	78,22b	24,8a
C. cosyra	19,72c	0d	2d

Means with the same letter are not very significant in the same species at the threshold α= 0.05

We note the predominance of the species *B. dorsalis* with shea, i.e. an average of 78.22 flies, followed by guava 24.85 flies. Conversely, a predominance of *C. cosyra* 19.72 flies with mango.

Temporal dynamics of the fly population: The average numbers recorded for the two fly species during the rearing period are presented in Figure 2.

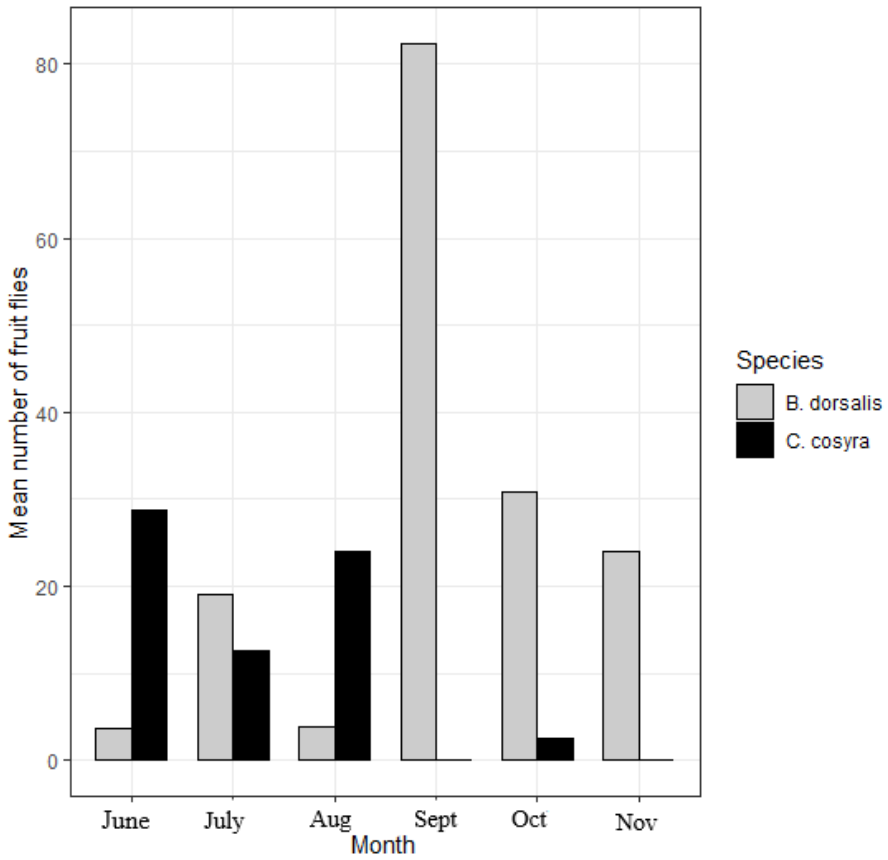

Figure 2. Variation of the fruit fly population.

The populations of both fly species vary greatly over time. The population of *B. dorsalis* is dominant from September to November, whereas that of *C. cosyra* is, globally dominant from June to August. The dynamics of the two species are alternated with the presence of *B. dorsalis* during the whole rearing period.

Effect of meteorological parameters on the fruit fly population: The data on fly were correlated with different meteorological parameters and have been presented in Table 2.

Table 2. Correlation between the fruit flies' population and meteorological parameters under the rearing conditions.

Species	Meteorological parameters	Correlation coefficient
B. dorsalis	Outside temperature (°C)	-0.043
	Indoor temperature (°C)	-0.034
	Relative humidity (%)	-0.069
C. cosyra	Outside temperature (°C)	0.12
	Indoor temperature (°C)	0.185
	Relative humidity (%)	0.004

N=38 * significant at 5% level

The data show that the correlations are not significant at the 5% level under our rearing conditions. However, the population of *C. cosyra* was slightly sensitive to the variation of the meteorological parameters, particularly the indoor temperature, compared to that of *B. dorsalis*, for which the correlation coefficients were negative for the three observed parameters.

Sex predominance of fruit fly species in rearing: Table 3 shows that there is no predominance between male and female in the two species of fruit flies of host plants (mango, shea and, guava).

Table 3. Difference in means between the sexes of the two species of flies in rearing.

Sexes/Species	*B. dorsalis*	*C. cosyra*
♀	10,89a	6,53b
♂	12,71a	6,35b

NB : Same letter means are not highly significant in the same species at the α= 0.05 threshold.

DISCUSSION

The life span of the pupae varied between species (*C. cosyra*, and *B. dorsalis*) under our rearing conditions. These results are similar to those of Duyck and Quilici (2002) for the genus Ceratitis. The results of the rearing of flies in the laboratory revealed two species: *B. dorsalis* and, *C. cosyra*. On the one hand, the predominance of the *B. dorsalis* species on shea, followed by guava, and on the other hand that of *C. cosyra* in mango can be noted. The presence of *B. dorsalis* in shea and guava could be explained by the infestation of the fruits in the orchards before sale in the market. This infestation would be due to the period of mango which draws toward its end but also which coincides with the maturity of shea and guava. The presence of *C. cosyra* in mango under laboratory rearing conditions (weather parameters) was almost identical to that in orchards. Indeed, *B. dorsalis* is a polyphagous species of great economic importance which develops especially on mango and guava, as reported by some authors such as Mwatawala *et al.* (2006); White (2006); Ndzana *et al.*

(2008). With N'diaye (2009), *Bactrocera invadens* infested 58 fruit plants in and around the studied orchards including, 18 citrus species and 24 mango varieties. The host plant range of *Bactrocera invadens* includes species from the families Rutaceae, Anacardiaceae, Capparidaceae, Rhamnaceae, Myrtaceae, Annonaceae, Caricaceae, Palmaceae, Sapotaceae, Caesalpiniaceae and Cucurbitaceae. According to Diatta *et al.* (2013), comparison between different fruit species showed that ripe papaya was more infested than ripe mango and citrus. The range of host fruits observed in the field appears to be influenced more by larval performance and interspecific competition than, by female preferences (2014). Hintenou *et al.* (2017) also recorded high development rates of *B. dorsalis* on *Irvingia gabonensis* (African apple) and *Musa sp* (pink banana) and that of *C. cosyra* on apple and papaya (Hintenou *et al.*, 20).

Throughout the rearing period, the fly species evolved in opposite directions, i.e., when one species explodes, the other becomes sporadic, as does the case of the infestation rate and even the fluctuation of flies in the three sites according to temperature and relative humidity. For example, De Souza *et al.* (2016) and ITA-CIRAD (2008) confirmed that the biology of insects depends on the temperature, relative humidity, and host plants. Similar to the infestation rate, the breeding results also show that there is no significant difference between male and female sex in the same species. These results are similar to those of Baldy (2014); Hintenou *et al.* (2017).

CONCLUSION AND APPLICATION OF THE RESULTS

The horticultural sector in Mali faces many challenges, including sanitary crises that cause significant losses. The objective of this study was to evaluate the preferences of fruit flies toward three host plants. The study revealed that among the fruits used as ovipositors, mango is the most preferred for oviposition by the two fly species *B. dorsalis* and *C. cosyra*. Female *B. dorsalis* laid eggs in all three fruits (mango, shea and, guava). These results can serve as a prerequisite for the identification and mass breading of beneficial insects effective against these fruit flies. Their release in orchards is a new control method that will considerably reduce fruit fly losses.

ACKNOWLEDGEMENTS

The authors would like to thank the CNRA (National Agricultural Research Committee) for its financial support and, the FST (Faculty of Sciences and Technologies) for its supervision and management of research funds. The owners of the orchards (Ibrahim Sangaré of Dougourakoro, Yacouba Traoré of Farabana and Sékou Sidibé of Kati).

Conflict of interest: No conflicts of interest have been reported. This study was carried out as part of my thesis research work at the Faculty of Sciences and Technology (FST) of the University of Technical Sciences.

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