

## Invasive fruit fly, *Ceratitis* species (Diptera: Tephritidae), pests in South Kivu region, eastern of Democratic Republic of Congo

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**ABSTRACT:** Damage due to fruit flies of the genus *Ceratitis* in orchards (mainly mango and citrus) is high but nothing is known about the fruit fly species involved in the South Kivu region. The tephritids flies were identified at the Research Centre in Natural Sciences (CRSN / Lwiro) and when identification was unsuccessful specimens were sent for identification to the Royal Museum for Central Africa (RMCA, Tervuren, Belgium). *Ceratitis fasciventris* was the dominant *Ceratitis* species captured during the entire experiment, biweekly. The former had pest dominant *Ceratitis fasciventris* and six *Ceratitis* individuals was found such as *Ceratitis anonae* (Graham), *Ceratitis capitata* (Wiedemann), *Ceratitis cosyra* (Walker), *Ceratitis fasciventris* (Bezzi), *Ceratitis punctata* (Wiedemann) and *Ceratitis rosa* (Karsch).

**KEYWORDS:** Genus, fruit, flies, Irhambi-Katana, Kabare.

### 1 INTRODUCTION

Flies (Diptera: Tephritidae) are considered the most destructive insect pests of fruit and vegetables in the world [[1]; [2]]. Without control, direct damage has been reported from 30 to 80% depending on the fruit, variety, location and fruit season [3].

The fruit fly genus *Ceratitis* Macleay (Diptera: Tephritidae) comprises several important pest species attacking a wide range of unrelated fruits [[4]; [5]].

Mediterranean fruit fly is also an important pest of several cultivated fruit such as coffee, mango, citrus spp. and other fruits in the country of the Great Lake of Central Africa [6]. Although widely distributed in the sub-Saharan region [[7]; [8]], Mediterranean fruit fly seems to be a less serious pest of cultivated fruit along the *Ceratitis fasciventris* (Bezzi), *Ceratitis anonae* (Graham), and *Ceratitis cosyra* (Walker). Damage to commercial fruit by these four other species can be considerable, for example, 20–30% of the mango crop is lost, on average, to *C. cosyra*, reducing export earnings and affecting the quality and price of locally sold fruit [9]. Additionally, [10] suggest that *C. rosa* may be better adapted to exploiting colder climates than is Mediterranean fruit fly.

Thus, current knowledge of *Dacini* fruit flies in the South Kivu region will be important because, potentially have an economic impact on local horticultural production.

The aim of this study is to identify the fruit fly *Ceratitis* species present and to determine dominant *Ceratitis* species in orchards on the South Kivu region.

However, very few studies were conducted in the Democratic Republic of Congo (DRC), and none in the South Kivu region.

## 2 MATERIAL AND METHODS

### FRUIT FLY IDENTIFICATION

Monitoring was carried out in private orchards located in Irhambi-Katana, rural area, territory of Kabare, and province of South Kivu at the eastern of DRC. Irhambi-Katana is located 1.654 meters above sea level (Geographical coordinates: 2°13'30"N and 28°49'53"E) (Table 1). Five fruit tree species – lure/bait pairs were established and repeated two times over three orchards (Table 1).

**Table1. Latitude, longitude, altitude (Meter), lure-bait and trees where the lure/baits were located**

N <sup>o</sup>	Latitude	Longitude	Altitude	Lure/bait	Trees	Characteristics of the
						orchards
<i>First repetition</i>						
1	02°12.7'42''	28°51.6'36''	1505	Cuelure +DDVP strip	<i>Mangifera indica</i> L.(Anacardiaceae)	Combination with cassava,sweet potatoes, avocado, lawn and others trees
	02°12.7'23''	28°51.6'10''	1500	Methyl eugenol +DDVP strip	<i>Eriobotrya japonica</i> (Thunb.) Lindley (Rosaceae)	
2	02°12.7'08''	28°51.6'16''	1461	Trimedlure+DDVP strip	<i>Citrus sinensis</i> Osbeck.(Rutaceae)	Combination with straw-berry, plum tree, egg-plant ,carrot and pepper
3	02°12.7'14''	28°51.6'34''	1665	Terpinyl acetate + DDVP strip	<i>Averrhoa carambola</i> L. (Oxalidaceae)	Combination with medicinal plants and vegetables
	02°12.7'23''	28°51.6'26''	1500	Liquid protein bait+ No DDVP strip	<i>Psidium guajava</i> L. (Myrtaceae)	
<i>Second repetition</i>						
1	02°12.7'43''	28°51.6'34''	1505	Cuelure +DDVP strip	<i>Mangifera indica</i> L.(Anacardiaceae)	Combination with cassava ,sweet potatoes, avocado, lawn and others trees
	02°12.7'23''	28°51.6'09''	1500	Methyl eugenol +DDVP strip	<i>Eriobotrya japonica</i> (Thunb.)Lindley(Rosaceae)	
2	02°12.7'00''	28°51.6'17''	1464	Trimedlure+DDVP strip	<i>Citrus sinensis</i> Osbeck.(Rutaceae)	Combination with straw-berry,plum tree,egg-plant ,carrot and pepper
3	02°12.7'16''	28°51.6'31''	1501	Terpinyl acetate+ DDVP strip	<i>Averrhoa carambola</i> L. (Oxalidaceae)	Combination with medicinal plants and vegetables
	02°12.7'24''	28°51.6'30''	1502	Liquid protein bait+ No DDVP strip	<i>Psidium guajava</i> L. (Myrtaceae)	

Both para-pheromone lures and food baits were used, (i) four para-pheromone lures attractive only for male fruit flies: Cuelure (4-(p-acetoxyphenyl)-2-butanone), highly attractive to melon fly, *B. cucurbitae* (Coquillett); Methyl eugenol (4-allyl-1,2-dimethoxybenzene-carboxylate), attractive to a large number of *Bactrocera* species including the oriental fruit fly, *B. dorsalis*; Trimedlure(t-Butyl-2-methyl-4-chlorocyclohexanecarboxylate), attractive to medfly *Ceratitis capitata*; Terpinyl

acetate (acetic acid terpinyl ester), attractive to many *Ceratitis* species including *Ceratitis cosyra*; and (ii) one food baits, the Liquid protein bait [protein hydrolysate, Nu-Lure (Miller Chemical and Fertilizer Corporation, Hanover, USA)] [11]. Food baits are less selective than para-pheromone lure and attract mainly female fruit flies. They are not species-specific and are known to have a lower efficiency compared to male lures [12]. All the lures/baits were used in combination with insecticide DDVP (2, 2-dichlorovinyl dimethyl phosphate) strip that were placed at the bottom of a McPhail trap to kill any attracted flies. The protein bait was changed after two weeks and the four other lures after two months. McPhail traps remained in place for six months during the fruiting season of mango from January 2014 to August 2014. The fruit flies were collected biweekly (till 07 January to 07 August 2014) in vials, stored in the isopropyl. The tephritids flies were identified at the Research Centre in Natural Sciences (CRSN / Lwiro) and when identification was unsuccessful specimens were sent for identification to the Royal Museum for Central Africa (RMCA, Tervuren, Belgium).

One way ANOVA statistical analyses were carried out to compare the number of *Ceratitis* species, pairwise comparison were used by the simple test t of Leaf Significant Difference (LSD).

### 3 RESULTATS

**Table 2. List of fruit flies *Ceratitis* species in eastern recorded in Democratic Republic of Congo**

N <sup>0</sup>	Species	Authorship	Rural village Muger- Mwanda (Katana) in Kabare (South Kivu)
1	<i>Ceratitis anonae</i>	(Graham), 1908	*
2	<i>Ceratitis capitata</i>	(Wiedemann), 1824	*
3	<i>Ceratitis cosyra</i>	(Walker), 1849	*
4	<i>Ceratitis fasciventris</i>	(Bezzi), 1920	*
5	<i>Ceratitis punctata</i>	(Wiedemann), 1824	*
6	<i>Ceratitis rosa</i>	(Karsch), 1887	*

*Ceratitis anonae*(Graham), *Ceratitis capitata* (Wiedemann), *Ceratitis cosyra* (Walker), *Ceratitis fasciventris* (Bezzi), *Ceratitis punctata*(Wiedemann) and *Ceratitis rosa* (Karsch) were caught during the experiment.

**Table 3. Number of *Ceratitis* species captured during the entire experiment per lure/bait**

Species	Lure/bait				
	Cuelure	Methyl eugenol	Trimedlure	Terpinyl acetate	Liquid protein bait
<i>Ceratitis anonae</i>	0	6	50	59	14
<i>Ceratitis capitata</i>	0	0	0	3	0
<i>Ceratitis cosyra</i>	3	0	17	120	5
<i>Ceratitis fasciventris</i>	18	103	630	680	67
<i>Ceratitis punctata</i>	0	2	0	0	0
<i>Ceratitis rosa</i>	0	0	0	2	0

The total number of *Ceratitis* individual caught during the experiment was 1779, concerning caught per lure/bait, we had a lot of caught with terpinyl acetate (864 individuals) then trimedlure (697 individuals), then again methyl eugenol (111 individuals), again liquid protein bait (86 individuals) and at the end cuelure (21 individuals) and concerning caught per *Ceratitis* individual *Ceratitis fasciventris* (1498 individuals), *Ceratitis cosyra* (145 individuals), *Ceratitis anonae* (129 individuals), *Ceratitis capitata* (3 individuals) and 2 individuals respectively for *Ceratitis rosa* and *Ceratitis punctata*.

**Table 4. Number of *Ceratitis* species captured during the entire experiment, biweekly (till 07 January to 07 August 2014)**

Weeks	<i>Ceratitis cosyra</i>	<i>Ceratitis fasciventris</i>	<i>Ceratitis anonae</i>	<i>Ceratitis capitata</i>	<i>Ceratitis punctata</i>	<i>Ceratitis rosa</i>
1	1	177	0	1	2	0
2	8	67	13	2	0	2
2	8	67	13	2	0	2
3	0	16	7	0	0	0
4	15	110	11	0	0	0
5	8	116	9	0	0	0
6	12	61	14	0	0	0
7	25	49	8	0	0	0
8	63	200	13	0	0	0
9	9	108	20	0	0	0
10	3	296	17	0	0	0
11	0	61	4	0	0	0
12	1	120	9	0	0	0
13	0	117	4	0	0	0
Mean	11	115	10	0	0	0

The mean number of *Ceratitis* species captured during the entire experiment, biweekly differed; *Ceratitis fasciventris* was dominant with 115 individuals then *Ceratitis cosyra* (11 individuals) and *Ceratitis anonae* (10 individuals). Anova, statistical analyse was represented in the table 4 a.

**Table 4 a. ANOVA of number of *Ceratitis* species captured during the entire experiment.**

Source of variance	d.f.	Sum of squares	Mean square	F	Signification	p(same)
Difference between number of <i>Ceratitis</i> species	5	145303	29060,6	32,3	***	1,08E-17
Difference within number of <i>Ceratitis</i> species	78	70174,8	899,677			
Total	83	215478				

Anova showed the more difference between the number of *Ceratitis* species fruit flies captured during the entire experiment, biweekly, i.e., the number of *Ceratitis* species caught differed per week then, the pairwise comparison of number of *Ceratitis* species (Table 4b).

**Table 4 b. Pairwise comparison of number of *Ceratitis* species captured during the entire experiment**

<i>Ceratitis</i> species	<i>Ceratitis cosyra</i>	<i>Ceratitis fasciventris</i>	<i>Ceratitis anonae</i>	<i>Ceratitis capitata</i>	<i>Ceratitis punctata</i>	<i>Ceratitis rosa</i>
<i>Ceratitis cosyra</i>		8,843	0,085	0,935	0,935	0,935
<i>Ceratitis fasciventris</i>			8,928	9,778	9,778	9,778
<i>Ceratitis anonae</i>				0,595	0,680	0,680
<i>Ceratitis capitata</i>					0,085	0,085
<i>Ceratitis punctata</i>						0
<i>Ceratitis rosa</i>						

The pairwise comparison showed *Ceratitis fasciventris* was the dominant *Ceratitis species* captured during the entire experiment, biweekly

#### 4 DISCUSSION

We found six *Ceratitis* individual in our study: *Ceratitis anonae* (Graham), *Ceratitis capitata* (Wiedemann), *Ceratitis cosyra* (Walker), *Ceratitis fasciventris* (Bezzi), *Ceratitis punctata* (Wiedemann) and *Ceratitis rosa* (Karsch) were caught during the experiment and the total number of *Ceratitis* individual caught during the experiment was 1779. *Ceratitis* is endemic to subsaharan Africa, where all of its described species occur [13].

Concerning caught per lure/bait, we had a lot of caught with terpinyl acetate (864 individuals) then trimedlure (697 individuals), then again methyl eugenol (111 individuals), again liquid protein bait (86 individuals) and at the end cuelure (21 individuals). There is a full range of feeding strategies from monophagy to polyphagy [7] within *Ceratitis*. As with other important genera of fruit infesting tephritids, pest species tend to be polyphagous.

And, concerning caught per *Ceratitis* individual *Ceratitis fasciventris* (1498 individuals), *Ceratitis cosyra* (145 individuals), *Ceratitis anonae* (129 individuals), *Ceratitis capitata* (3 individuals) and 2 individuals respectively for *Ceratitis rosa* and *Ceratitis punctata*. In 2006, [13] in their study, showed that *C. fasciventris* had the most data for both native ( $n = 20$ ) and exotic ( $n = 9$ ) plant hosts. *C. fasciventris* also was distributed widely throughout the central Kenya highlands, collected at elevations of up to 2,220 m, but it was absent from the coast. *Ceratitis fasciventris* was the dominant *Ceratitis* species captured during the entire experiment, biweekly. *C. fasciventris* had the greatest diversity of hosts, both in terms of plant species and families [13].

#### 5 CONCLUSION

This study shows that several of the pest *Ceratitis* species found in South Kivu region, such as *Ceratitis anonae*, *Ceratitis capitata*, *Ceratitis cosyra*, *Ceratitis fasciventris*, *Ceratitis punctata* and *Ceratitis rosa*, could potentially have an economic impact on local horticultural production. It is highly likely, in this region, *Ceratitis fasciventris* is a dominant pest of the genus *Ceratitis*. It is suggested that more detailed studies of the genus *Ceratitis* in South Kivu region, eastern Democratic Republic of Congo should be conducted in the future.

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