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Species composition of fruit flies (Dipteral:Tephritidae) and extent of damage on mango fruit in eastern Ethiopia

Dawit getahun[1], Feredu Azerefegne[2], and Yibrha Beyeneh[2]

[1]Adigrat University, College of agriculture and environmental science, Department of Plant science, Adigrat, P.O Box 50, Ethiopia

[2]Hawassa University, College of Agriculture, Department of Plant science, Hawassa, P.O Box O5, Ethiopia

ABSTRACT: A study was conducted to determine the species composition of fruit flies attacking mangoes and, the extent of mango fruit losses in selected areas of eastern Ethiopia. Fruit flies were collected using two methods; rearing from mango fruits and trapping with the use of Para pheromones. Six species of Tephritidae were reared from mango fruits: Ceratitis fasciventris, Ceratitiscosyra, Bactroceracucurbitae, Dacusbivittatus, Ceratitisquinaria and Ceratitiscapitata. 83.1 %, 12.8%,. 2.7%, 0.7 %, 0.4 % and 0.21%, respectively. Nine fruit flies species, four of the genus Ceratitis, (C. cosyra, C. quinaria, C. capitata and C. fasciventris), three of Dacus (D. bivittatus, D. telfairae and D. apoxanthu), and two of Bacterocera (B. invadens and B. cucurbitae), were collected using different parapheromones (Methyl eugenol, Cuelure, 3Component lure, Trimedlure and Terpinyl Acetate)from mango farms in eastern Ethiopia. Using pheromone traps three new fruit fly species were identified. Out of all species Ceratitisfasciventris were dominant followed by Ceratitiscosyra and Dacusbivittatus. All species has no relation with altitude. The extent of mango infestation on the average ranged 21 to 35% in different locations of Eastern Ethiopia. The overall mean percentage of mango losses is 30.4%.

KEYWORDS: fruit fly, species composition, par pheromone, traps.

1 INTRODUCTION

Many species of fruit flies attack different types of commercial and wild fruits and vegetables, causing considerable damage to agricultural crops [3].

[9]In Africa about 950 species and 150 genera of fruit fly (Tephritidae) are known, out of which 299 species develop in either wild or cultivated fruits. Some were accidentally introduced in Africa from other regions, in particular from Asia [4]. Asian fruit flies from genus Bactrocera are regarded as some of the destructive insects of fruit [11]. The presence of *Bactrocerainvadens* in the southern and western Ethiopia was reported [6]

Mango originated in South-East Asia and introduced to all other tropical regions. In each region where it is grown, mango is attacked by fruit flies from different genera: *Anastrepha, Bactrocera*, *Ceratitis* and *Dacus*. The genus *Ceratitis* is endemic to the Afro tropical region, and contains about 65 species, the majority of which are highly polyphagous [11]. Mango is commonly attacked by varying combinations of four major species across Africa: *C.cosyra, C. fasciventris*, *C. rosa*and *C. sanonae* and much less frequently, by *C. capitata* [8]

Fruit flies attack ripe mangoes and inflict damage to the fruit either directly (larvae feeding on pulp) or by causing blemished fruit, which limits marketing possibilities (especially export of fruit [1]. Of the 1.9 million tons of mangoes produced in Africa annually, about 40% is lost due to fruit flies where infestation rates vary among countries and seasons, ranging from 5% to 100% [8].

Corresponding Author: Dawit getahun

Different factors attribute for the level of fruit infestation and extent of loss by fruit flies. The level of mango fruit ripening can influence the extent of damage by post harvest diseases and insect pests [7]. The type of mango cultivar could also influence fruit flies attack. It is known that each species of fruit might be attacked by a number of fruit fly species and the importance of the fruit fly species may differ according to the type of the fruit and the area [11]. The species composition and relative abundance of fruit flies are also important factors of attacks.

Studies on the species composition of fruit flies attacking various fruits in Ethiopia are lacking. Earlier studies have shown that *C. capitata* was present in many parts of the country [10; 5; 2; 6]. In the eastern Ethiopia and the central Rift Valley regions both *C. capitata* and *C. fasciventris* are the co-dominant species [6]. *C. fasciventris* was earlier identified on mangoes at Upper Awash Agro-Industry Enterprise (UAAIE) [2]. Knowledge on the species of fruit flies is basic to design monitoring methods and development of appropriate management practices. Therefore this study was conducted to determine the species composition of fruit flies attacking mangoes and and the extent of mango fruit losses they cause in selected areas of eastern Ethiopia.

2 MATERIALS AND METHODS

2.1 DESCRIPTION OF STUDY AREA

The study was conducted in Woredas (districts) of Babile, Bedeno, Erergota. Gursum and Harari regional state, areas known for mango production in eastern Ethiopia (Table 1). Babile Woreda is located to 557 km from Addis Ababa and on $9^0 12' 930''$ N and $42^0 18' 061''$E with an elevation of 1200-1800m above sea level. (Information collected from Agricultural and Rural Development Office of Babile Woreda).

Babile woreda ($9^0 12'930''$N and $41^0 21'457''$E.) the altitude of this wored ranges from 1200-1800 above sea level. The minimum temperature of the woreda is 10^0C and with the maximum of 20^0c. This wored have an annual rain fall of over 600mm. (information collected from agricultural and rural development office of Babile woreda)

Badano woreda ($9^0 31'459''$N and $41^0 21'457''$E)the altitude of this woreda ranges from 1200-3100 above sea levelThe rain fall of the woreda are binomial with medium amount of rain fall in "Belg" which last from March to April and main rainy season "Keremt" which is from June to September

Gursum woreda is located 600 km from Addis Ababa, at ($09^0 37'320''$N and $042^0 43'820''$E) with an elevation of 1400-2300m above sea level.

Harari regional state is located on 535km distance from Addis Ababa and with an elevation ranges from 1300-2200m.a.s.lat 9° 15' 00" N and 42° 10' 00" E.. Temperature is even between 17.1°c-20.2°c throughout the year.

Erergotaat $09^0 54'939''$N and $41^0 03'913''$E with an average elevatin 824 meter above sea level. the minimam and maximam temperature of the district is 19^0 c and 31^0c respectively. a sample enumeration performed by the CSA in 2001 interviewed 2870 farmers in the woreda, who held an average of 0.4 hectares of land.

Location	Positions	Altitude	Temp range	Rainfall
Babile	$9^0 12' 930''$ N, $42^0 18' 061''$E	1200-1800m	10^0C- 20^0c	600 mm
Badano	$9^0 31'459''$N, $41^0 21'457''$E	1200-3100	16^0c- 27^0c	1926mm
Error Gota	$9^0 31'59.988''$N, 41023'60.000"E	824	19^0c -31^0c	150-1000
Gursum	$09^0 37'320''$N, $42^0 43'820''$E	1400-2300m	14^0C- 24^0C	650-850mm
Harari	9° 15' 00" N, 42° 10' 00" E	1300-2200m	17.1°c-20.2°c	750- 1,509 mm

2.2 DETERMINATION OF FRUIT FLY SPECIES ON MANGOES

Two methods of sampling were employed to collect the species of fruit flies, rearing of larvae to adult stage from infested mango fruits and trapping of adult fruit flies using Para pheromones lures.

2.2.1 REARING OF FRUIT FLIES FROM MANGO FRUITS COLLECTED FROM DIFFERENT AREAS OF EASTERN ETHIOPIA

In each wored a three mango farms were surveyed and from each farm five kg ripe mango fruits with ovipunctures of fruit flies were sampled. The fruits were kept in plastic bucket of 10 liters capacity with moistened fine sand at the bottom for pupation and left in the bucket for 30 days.

The plastics were covered by cotton cloth to allow air circulation but keep the emerging flies inside the plastic. The plastic containers were checked every 3-4 days for puparia and adult flies. Puparia were sieved from sand and placed in transparent glass (Petri dish) for adult emergence. The flies in the bucket were kept until all died and collected and preserved in vials containing ethanol 97% for further identification.

2.2.2 COLLECTION OF FRUIT FLIES USING DIFFERENT PARAPHEROMONES IN EASTERN HARAGHE

Five different parapheromones namely Cue lure, Methyl Eugenol (ME), Trimedlure (TML), 3 components Lure (3C), and Terpinyilacetae (TA), were used to attract the fruit flies. Empty water bottles of one-liter capacity were used for making a modified trap bottle. Entry holes with a diameter of 2.5cm were punched at four equidistant places at 2/3level of the bottle using hot iron rod and the solid baits were placed in the bottle except Terpinyl acetate which is liquid and it is placed in the bottle using piece of cotton wick. Solid dichlorovos (Vapona) were used to kill the fly in the bottle. The trap bottles with the baits were suspended with a string on mango trees at a height of two to three meters from the ground for three days. Each lure was replicated three times in each area. The trapped flies were preserved in vials containing ethanol 97% for further identification. New water bottles traps were used to avoid contamination of the outer surface of the bottles with the baits which may keep the flies to settle to the outer side of the bottle instead of getting in.

The abundance and dominance of fruit fly species were determined with the formula used by Shorma (2004)

A= (∑W/N), where A =Abundance, ∑w=sum of individual of a particular fruit fly species across all samples, N=total number of samples.

The dominance of fruit fly species was determined using the formula

D=Ax100/ (∑W), where D=Dominance of particular species A=abundance of the same species,

∑w= total abundance of an individual fruit fly species in relation to total fly abundance.

Descriptive statistics was used to compare the relative abundance of the species of fruit flies attacking mangoes.

2.3 DETERMINATION OF THE EXTENT OF YIELD LOSS ON MANGOES BY FRUIT FLIES

A minimum of 10Kg of ripe mango fruits were sampled from each farm and sorted in to "Infested" and "Non Infested" categories by examining rotting and the ovipunctures of fruit flies. Each category were counted and weighed. The clean looking mango fruits were kept in fruit containers for a week then dissected for the presence of fruit fly larvae. The proportions of damaged fruits were added in to "Infested" category to recalculate the level of infestations. The data were subjected to ANOVA and means were separated using Tukeys HSD test at P=0.05.ewith SAS Statistical Program.

3 RESULTS

3.1 FRUIT FLY SPECIES FROM MANGO FARMS IN DIFFERENT DISTRICTS OF EASTERN HARARGHE

Table 1. Species of fruit flies reared from mango fruit collected from different woredas of Eastern Ethiopia, 2010.

Tephritid Species recorded	Number of adult fruit flies reared /kg mango fruit					
	Babile	Gursum	Harar	Bedano	Erergota	Total %
Bactroceracucurbitae	6	4	8	5	3	2.7±0.86
Ceratitiscapitata	2	0	0	0	0	0.2±0.39
Ceratitiscosyra	34	34	37	15	4	12.8±0.24
Ceratitisfasciventris	134	175	223	178	93	81.1±0.26
Ceratitisquinaria	0	1	2	0	1	0.4±0.25
Dacusbivittatus	1	1	3	2	0	0.7± 0.51
Total number	177	215	273	200	101	

Table 2. Total species of fruit flies collected in mango farms in different woredas of eastern Hararghe using different Para pheromones, 2010

Species recorded	Number of fruit flies/trap /day collected by different Para pheromones							
	ME	TML	CUE	3C	TA	Total	%	Abundance
Bactroceracucurbitae	0	6	57	8	3	74	4.7±10.7	14
Bactrocerainvadens	11	37	3	0	0	51	3.2±6.9	10.2
Ceratitiscapitata	0	2	0	0	2	4	0.3±0.48	0.8
Ceratitiscosyra	0	0	1	49	164	214	13.6±31.3	42.8
Ceratitisfasciventris	0	357	8	327	511	1203	76.3±13.5	240.6
Ceratitisquinaria	0	0	0	0	8	8	0.5±1.6	1.6
Dacusapoxanthus	0	0	0	1	0	1	0.1±0.2	0.2
Dacusbivittatus	2	0	18	0	0	20	1.3±3.5	4
Dacustelfairae	0	0	0	1	0	1	0.1±0.2	0.2
Total	**13**	**402**	**87**	**387**	**688**	**1576**		

NOTE: ME = Methyleeugnole, CUE = Cuelure TA = Terpinyl acetate, 3C = Three component lure, TML = Trimedlure, ± =SE.

Table 3. Fruit fly species trapped by different Para pheromone in Erergota, eastern Haraghe, Ethiopia, 2010.

Fruit fly Species	Number of fruit flies/trap /day collected by different Para pheromones							
	ME	CUE	TML	3C	TA	Total	%	Abundance
B. invadens	11	3	37	0	0	51	60.7±7.53	10.2
B. cucurbitae	0	0	1	0	0	1	1.2±2.17	0.2
D. bivittatus	2	0	0	0	0	2	2.4±0.44	0.4
C. cosyra	0	0	4	0	4	8	9.5±0.89	1.6
C. fasciventris	0	0	11	0	10	21	26.2±0.22	4.2
Total	13	3	53	0	14	83		

NO TE: ME = Methyleeugnole, Cue = Cuelure, TA = Terpinyl acetate, 3C = Three component lure TML=Trimedlure, ± = SE

Table 4.Species of fruit flies trapped by different Para pheromone in Babile area, eastern Haraghe, Ethiopia, 2010.

Fruit fly Species	Number of fruit flies/trap /day collected by different Para pheromones							
	ME	CUE	TML	3C	TA	Total	%	Abundance
B. cucurbitae	0	2	2	0	1	5	1.6±0.44	1
C. cosyra	0	0	0	9	27	36	11.±5.07	7.2
C. fasciventris	0	1	71	91	103	266	85.8±22.15	53.2
C. quinaria	0	0	0	0	5	5	0.7±1.00	1
D. telfaireae	0	0	0	1	0	1	0.3±0.2	0.2
Total	0	3	73	101	136	313		

NO TE: ME = Methyleeugnole, Cue = Cuelure, TA = Terpinyl acetate, 3C = Three component lure TML=Trimedlure, ± = SE

Table 5. Species of fruit flies trapped by different Para pheromones in Gursum, eastern Haraghe, Ethiopia, 2010.

Fruit fly Species	Number of fruit flies/trap /day collected by different Para pheromones							
	ME	CUE	TML	3C	TA	Total	%	Abundance
B.cucurbitae	0	1	0	0	0	1	0.85±0.2	0.2
C. cosyra	0	0	0	0	1	1	0.85±0.2	0.2
C. fasciventris	0	2	39	34	40	115	98.3±9.06	23
Total	0	3	39	34	41	117		

NOTE: ME=Methyleeugenol, Cue=Cuelure, TA=Terpinyl acetate, 3C=Three component lure, TML=Trimedlure, ± = SE

Table 6. Fruit flies species trapped by different Para pheromones in Bedano, eastern Haraghe Ethiopia, 2010.

Fruit fly Species	Number of fruit flies/trap /day collected by different Para pheromones							
	ME	CUE	TML	3C	TA	Total	%	Abundance
B. cucurbitae	0	12	2	0	2	16	2.82±2.25	3.2
C. cosyra	0	1	0	13	58	72	12.7±11.2	14.4
C. fasciventris	0	2	107	141	227	477	84.3±4331	95.4
D. apoxanthus	0	0	0	1	0	1	0.2±0.2	0.2
Total	0	15	109	155	187	566		

NOTE: ME=Methyleeugenol, Cue=Cuelure, TA=Terpinyl acetate, 3C=Three component lure, TML=Trimedlure, ± =SE

Table 7. Species of fruit flies trapped by different Para pheromones in Harari, eastern Ethiopia, 2010

Fruit fly Species	Number of fruit flies/trap /day collected by different Para pheromones							
	ME	CUE	TML	3C	TA	Total	%	Abundance
B. cucurbitae	0	42	1	8	0	51	10±8.1	10.2
D. bivittatus	0	18	0	0	0	18	3.6±3.59	3.6
C. capitata	0	0	1	0	2	3	0.69±0.39	0.6
C. cosyra	0	0	0	27	74	101	20.1±14.4	20.2
C. fasciventris	0	3	129	61	131	324	64.8±28.8	64.8
C. quinaria	0	0	0	0	3	3	0.6±0.6	0.6
Total	0	63	131	96	210	500		

NOTE: ME=Methyleeugenol, Cue=Cuelure, TA=Terpinyl acetate, 3C=Three component lure, TML=Trimedlure, ± = SE

3.2 DISTRIBUTION OF FRUIT FLY SPECIES IN RELATION TO ALTITUDE

Table 8. The relationship between altitude and composition of fruit flies species in Eastern Ethiopia, 2010

Fruit fly species	Range of Altitude (m.a.s.l)	Relationship	p-value
Bactroceracucurbitae	785-1684	y = 0.006x - 3.3934 R^2 = 0.0332	0.51
Bactrocerainvadens	785 -874	y = -0.0175x + 27.695 R^2 = 0.3442	0.021**
Ceratitiscapitata	1491-1554	y = 0.0004x - 0.2787 R^2 = 0.027	0.56
Ceratitiscosyra	785-1673	y = 0.0092x + 1.5536 R^2 = 0.0437	0.45
Ceratitisfasciventris	785-1684	y = 0.067x - 11.623 R^2 = 0.1404	0.17
Ceratitisquinaria	1575		
Dacusbivittatus	785-1575	y = 0.0014x - 0.6418 R^2 = 0.0105	0.71
Dacustelfaireae	1669		
Dacusapoxanthus	1271	y = -7E-05x + 0.1681 R^2 = 0.0089	0.73

**** = significant R^2 = Regression coefficient***

3.3 EXTENT OF MANGO INFESTATIONS BY FRUIT FLIES IN DIFFERENT FARMER'S FIELD IN EASTERN HARARGHE, ETHIOPIA, 2010

Table.10. The extent of mango fruit infestation by fruit flies different areas of Eastern Hararghe

Area	Total number of fruit sampled	% number of fruits infested
Babile	162	34.4±5.1^{ab}
Gursum	167	33.4±4.9^{ab}
Harari	184	35.4±4.43^{a}
Bedeno	181	21.6±4.4 ^{b}
ErerGota	180	26.9±2. 2^{ab}
C V		13.8

Means followed by the same letter within a column are not significantly different according to Tukey's HSD test at P<0.05. ± = standard error of the mean

4 RESULT AND DISCUSSION

4.1 FRUIT FLY SPECIES REARED FROM MANGO FRUITS

Six species of fruit flies were reared from mango fruits in selected fruit growing areas of eastern Ethiopia with a composition of *C. fasciventris*81.13%, *C. cosyra*12.8%, *B.cucurbitae*2.69%, *D. bivittatus*0.72%, *C.quinaria*0.41 % and *C. capitata*0.21% (Table 1). *C. fasciventris* was the dominant species in all districts followed by *C. cosyra.* The highest number of fruit flies was recorded in Harari Woreda followed by Gursum and the lowest in Erer Gota. *B. cucurbitae* was the third numerous species, followed by *D. bivittatus, C. quinaria*and *C. capitata* in descending order.

Out of all the fruit flies reared from mango fruits only three of the species, *C. capitata,* C *fasciventris* and *D. bivittatus,* were previously recorded in Ethiopia (Azerefegne*et al*., 2007), while the remaining three species, *B. cucurbitae, C. cosyra*and *C. quinaria*, are new records.

The African invading fruit fly *(B. invadens)* was not reared from mango fruits sampled in ErerGota although it was trapped by Parapheromone. *B. invadens* being a recent introduction to the continent and the country its retrieval only in the lure traps but not in fruits could be due to its recent introduction and establishment in the area the low sample size of fruits.

4.2 FRUIT FLY SPECIES COLLECTED IN MANGO FRUIT FARMS IN EASTERN HARARGHE USING DIFFERENT PHARAPHEROMONE

Nine fruit flies species four s of the genus *Ceratitis*, *(C. cosyra*, *C. quinaria, C. capitata* and *C. fasciventris),* three of *Dacus* (*D. bivittatus, D. telfairae* and *D. apoxanthu*), and two of *Bacterocera* (*B. invadens* and *B. cucurbitae*) were collected using different parapheromones from mango farms in eastern Ethiopia(Table 2).

The paraphermones differed in the species of fruit flies they attracted; Cue lure attracted *B. cucurbitae, C. cosyra*, *C. fasciventris, D. apoxanthus* and *D. telfaireae,* and TA *B. cucurbitae, C. cosyra*, *C. fasciventris*, *C. quinaria* and *C. capitata.* TML attracted *B. cucurbitae*, *C. fasciventris*, *C. capitata* and *B. invadens*, 3C attracted *B. cucurbitae, C. fasciventris*, *C. cosyra* and *D. telfaireae* while ME attracted *B. invadens* and *D. bivittatus*only at Erergota (Table3).

*B. invadens*is anew species record for eastern Hararghe, which was collected by ME, TML and Cue lure at Erergota (Table 3). Other new species, *D. telfairae* and *D. apoxanthus,* were collected only by the 3C in very low numbers at Babile and Bedeno, respectively (Table 4 and 6) while low number of *C. quinaria* were trapped only by TA at Harari (Table 7). De Meyer, (2001a) and White and Elson-Harris (1992) reported that males of *C. cosyra* do not respond well to commercially available parapheromone lures such as Trimedlure (TML), CueLure, or Methyl Eugenol (ME). As this report they do respond, however, to terpinyl acetate, β-caryophylene and several other terpenoids. Females respond to food baits such as Nulure. In this research *C. cosyra* was collected with Cue Lure. Males of *C. capitata* respond well to TML, and to a certain extent also to terpinyl acetate and other terpenoids and females respond to Nulure (De Meyer,2001b).The numbers of fruit flies were more abundant in the Bedeno, Harari and Babileworedas than in the Gursum and Erergota (Table 2)

A Total of 1576 fruit flies were caught by the different Para pheromones. Terpinyl acetate attracted 511*C. fasciventris* 164,*C. cosyra*, Trimedlure1576 *C. fasciventris* and 37*B. invadens*), 3C327 *C. fasciventris* and 49 *C. cosyra*, Cue lure (57 *B. cucurbita* and 18 *D. bivittatus* and Methyl Eugenol 11 *B. invadens*and2 *D. bivittatus)* (Table 2).

The African invading fruit fly *B. invadens* which is described as a new polyphagus species and originally from the Indian sub continent was recorded and has invaded tropical Africa (Drew et al., 2005). Initially, the new fruit fly species was

identified as *B. dorsalis* because it is morphologically similar (Drew *et al*., 2005). It was recorded in Kenya in February 2003 and it also invaded Democratic Republic of Congo, Senegal and Tanzania (Anonymous, 2005). *B. invadens* was new for Eastern Ethiopia. During the survey conducted in 2007 *B. invadens* was reported only from southern and western Ethiopia including Arbaminch, Asossa, Arjo, Bako, Gambella, Gibe, Ghimbi, and Welkitie on guava and mango (Azerefegne*et al*., 2007). The current study showed that *B. invadens* has established in some parts of eastern Ethiopia.

C. fasciventris was the most numerous fruit fly species present in all mango farms of eastern Ethiopia in this study, except at Erergota in which *B. invadens* was dominant (Table 3). A survey conducted in 2007 both *C. capitata* and *C.fasciventris*were the co-dominant species in the eastern Ethiopia (Azerefegne *et al*., 2007). *C. fasciventris* was identified for the first time in 2006 on mangoes at Upper Awash Agro-Industry Enterprise (UAAIE) (Birtukan, 2006). *B. cucurbitae* principally an Asian species is a new record foreastern Ethiopia (Table 2-7). The first specimens of *B. cucurbitae* in collections date from the early 1930s from the African mainland, as well as from Mauritius and Reunion islands (White *et al*, 2001;), but it might have been established much earlier. It is currently reported from several countries in East and West Africa: Benin, Burkina Faso, Cameroon, Gambia, Guinea, Ivory Coast, Mali, Niger, Nigeria, Senegal and Togo in western Africa, and Kenya, Sudan, Tanzania and Uganda in eastern Africa (White, 2006).

C. cosyra was recorded for the first time in the country in all surveyed woredas except in Babile (Table 4). *C. cosyra*, commonly known as the mango fruit fly is a serious pest in smallholder and commercial mango across sub-Saharan Africa and has been recorded in Ivory Coast, Kenya, South Africa, Tanzania, Uganda, Zambia and Zimbabwe, where it is more destructive than either the Mediterranian fruit fly (*C. capitata*) or the natal fruit fly(*C. rosa*) (Malio 1979; Labuschagne*et al*. 1996; Javaid 1979; Rendell *etal.* 1995; Lux *et al*., 1998).

C. quinaria is another new fruit fly species recorded in Ethiopia for the first time in Harari region (Table 7). Geographically it was distributed in Africa: Botswana, Malawi, Namibia, South Africa, Sudan, Zimbabwe and Asia: Yemen. Like many *Ceratitis spp.*, it is attracted to terpinyl acetate but not to Cue lure and trimedlure (Cunningham, 1989). *C. quinaria*was collected withTA only in this research. *D. bivittatus* and *D.telfairae* were also new species recorded in Ethiopia. *D. bivittatus*is distributed from Senegal East to Kenya, and south to South Africa; while *D. telfairae* was reported from Kenya, Tanzania, Malawi, Zimbabwe (Liquido*et al.,* 1989)

4.3 DISTRIBUTION OF FRUIT FLY SPECIES IN RELATION TO ALTITUDE

C. cosyra, *C. fasciventris*, and *Dacusbivittatus* were collected in wider altitudinal ranges (Tabl8). *C. capitata* was recorded only around 1500masl. *Ceratitisquinaria, D. telfaireae* and *Dapoxanthus* has restricted altitudinal ranges. In this study, *B. invadens* was recorded in the lower altitudes only and its number decreased with the increase in altitude (y = -0.0175x + 27.695, R^2 = 0.3442, P=0.021). The other fruit fly species did not show clear relationship with the altitude. This might be as a result of very few data sets used and there is a need for extensive surveys to make concrete conclusion

4.4 EXTENT OF MANGO INFESTATIONS BY FRUIT FLIES IN DIFFERENT FARMER'S FIELD IN EASTERN HARARGHE, ETHIOPIA, 2010

The extent of mango infestation by fruit flies on the average ranged from 21 to 35% in different locations of Eastern Ethiopia (Table 3). High infestations were recorded in Harari, Babile and Gursum with respective mean infestations of 35.43%, 34.43% and 33.40% (Table 10). The lowest infestation (21.6%)was observed in Bedano. Infestation levels vary among seasons, countries, regions, agro-ecological areas and cultivars (Vayssièresa et al 2009). Lux e*t al* (2003a) reported that of the 1.9 million tons of mangoes annually produced in Africa about 40% was lost due to fruit flies although these data concern losses before the arrival of the exotic fly *B. invadens*.

5 CONCLUSION AND RECOMMENDATION

Nine fruit fly species namely *B. invadens*, *B*. *cucurbitae* C*. fasciventris, C. cosyra, C. capitata, C. quaniria*, *D. bivittatus* and *D*. *apoxanthus*were collected using various paraphermones. In all areas studied, C*. fasciventiris* was the dominant fruit fly species.

In the eastern Ethiopia six fruit fly species, (*B. cucurbitae, D. bivittatus, C. capitata, C. cosyra, C. fasciventris*and *C. quinaria)* were reared from mango fruits. Out of the six species C*. fasciventris* appeared to be dominant, followed by *C. cosyra* while *B. cucurbitae,D. bivittatus, C. quinaria* and *C. capitata* in a descending order of their numbers.

Except *B. invadens*, clear relationship between altitude and population density of the fruit flies could not be established probably due to the limited number of locations in the study. *B. inavdens* was recorded only at Error Gota (743-874masl),

which is a low land compared to the other study areas. *C. fasciventris,* which was found in higher numbers, seems to have wider distribution.

Extent of mango infestation varied among the different areas studied and ranged from 21.6 to 35.4%. High level of infestations was recorded in Harari, Babile and Gursum with respective mean infestations of 35.4%, 34.4% and 33.4%, respectively. The lowest infestation was observed in Bedeno although 21.6% of the fruits were damaged by fruit flies.

Mango losses could be higher with the introduction and establishment of B. invadens. There is a need for monitoring ion the distribution of the fruit flies. The use of the management of the fruit flies demands on attractants

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