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Monitoring of Tephritidae of Fruit Trees and Their Level of Infestation in South Kordofan State, Sudan

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Abstract – **Fruit flies (Diptera: Tephritidae) are the most serious insect pests of fruits and vegetables in Tropical and subtropical areas of the world. They destroy horticultural produce by oviposting in fresh plant tissues while still on the plant and causing serious economic losses .The present study was carried out in South Kordofan State, Sudan, particularly in Abugubeiha region to identify fruit fly species which prevailed in the area and infestation levels causes by fruit flies species. The field monitoring of Tephritid fruit fly species using Nulure as a food attractant revealed the presence of three species, namely mango fruit fly *Ceratitis cosyra*, which was the dominant species in the region, melon fly, *Bactrocera cucurbitae* and the Asian fruit fly, *Bactrocera invadens*. Infestation level caused by fruit fly in Abugubeiha area was much higher (67%) in guava the second season. In the first season, the highest recorded level was also in guava (51%) followed by mango (31%) and grapefruit (18%), respectively.**

Keywords – **Fruit Flies, Monitoring, Nulure Attractant, Mcphail Trap, Infestation.**

I. Introduction

Fruits and vegetables have the potential to become an important source of income generation for African farmers through creating job opportunities as well as improving their diet by providing micronutrients and vitamins. Horticultural production in most African countries is limited by many biotic and a-biotic constraints. Biotic factors include, among others, heavy fruit fly infestation. Fruit-infesting Tephritidae is one of the most serious biotic constraints affecting horticultural production. They constitute enormous threats to fruit and vegetable production throughout the world [1]. In the tropics, the problem is aggravated by the prevailing warm weather, which is conducive to asynchronous fruiting patterns, resulting in overlapping generations and the potential of infestation all the year round [1]. Mango, *Mangifera indica* L., for instance, suffers losses of 30-80% in Nguruman, Kenya [2]. In Zanzibar, mango losses were reported to be as high as 100% during years of the outbreak [1]. The family Tephritidae (= Trypetidae), the true fruit flies, includes about 4000 Species assigned to 500 genera. As such, it is amongst the largest of Diptera families (true flies), and, economically, one of the most important pestiferous groups [3].Fruit flies of the family Tephritidae are the most injurious pests attack horticultural crops all over the world causing severe economic losses. In Sudan, fruit flies affect seriously the production and exportation of various fruit especially mango and citrus. The situation is going worst after the interception of B. Invadens to the country in 2005.Different protein hydrolastes are used globally to monitor the population of fruit flies. Ammonia is an essential substance that used as food by the females of fruit flies in order to develop eggs [4], [5], [6], [7], [8], [9]. Due to the lack of information about fruit fly species in Sudan particularly in Abugebeha areas in South Kordofan State. This work aimed to understanding of the diversity of fruit flies species infesting Mango and Citruses (Orange and Grapefruit) in Southern Kordofan and to evaluate the magnitude of fruit losses caused by fruit flies infesting Mango, Grapefruit and Guava in Abugebeha areas.

II. Materials and Methods

Study Area:

This study was conducted in South Kordofan State. South Kordofan State composes of five provinces (Kadugli, Rashad, Talodi, El delleng and Abugubeiha). It covers an area of approximately 141, 096km^2 and lies between latitudes 9-13º N and longitudes 27- 33ºE. Abugubeiha city is located between latitude 11º:27ó:33ó North and langitude31º:13ó:55ó.

Monitoring of Fruit Flies Using Liquid Food Bait

The experiment was carried out in four orchards at Abugubeiha area, which is located in south Kordofan State, 1000 km South of Khartoum, during the seasons 2005/2006 and 2006/2007. The selected orchards contain mango trees as the main plantation, grapefruit, banana, orange and guava. The neighboring farms were grown with eggplant, tomato and papaya. McPhail trap Fig I was used in this experiment. It is a cylindrical plastic traps

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composed of two separate parts, yellow base of trap with an opening at the bottom , and upper transparent part with hook . The type of food bait used was Nulure, two hundred and fifty ml of bait solution (Nulure (9%), borax (3%) and water (88%) was dispensed per trap. The traps were hung 2-3 meters from the ground in shaded fruit trees, on strong branches to support the weight of the trap. Five traps per orchard were used in this experiment. The traps were serviced weekly and the bait was replaced with newly mixed solution. At the same time, the caught flies were collected using a fine camel hairbrush, and then placed in labeled vials containing 70% ethanol. The specimens were identified at the Insect collection unit, ARC, Wad-Medani-Sudan and some specimens sent to ICIPE for identification. The number and sexes of each fruit fly species were recorded.

Infestation levels

The infestation levels due to fruit fly infestation, was carried out during the seasons 2005/2006 and 2006/2007), at Abugubeila in three different locations. Mango (variety "Abusamaka"), Guava and Grapefruit were selected for this study. Hundred fruits from each of the mentioned species were randomly collected from the trees. Sampling was done diagonally. Fruit samples were collected according to age and classified as fruit lets, mature or ripe. Collected fruits were secured in well–aerated plastic containers covered with a fine mesh, and transferred to a laboratory for rearing. Each fruit sample was reared in a separate container. Large fruits were kept in the open and checked daily for visible signs of fruit fly larvae, then split into pieces and placed in a container shortly the mature larvae popped out of the fruit. The bottom part of each box was lined with moistened sand, which will act as a pupation medium for larvae that exit the fruits. After 3-5 days, the pupae were picked from the sand and held in mini Petri dishes with another Petri dishes containing moistened cotton wool. Then pupae were placed in small cages until adult emergence. Emerging flies were provided with artificial diet of hydrolysate yeast powder and sugar in a ratio of 4: 1 for 3-4 days till full adult development and coloration is reached after which they were killed in a freezer, identified and preserved in vials in 70% alcohol. The numbers as well as sex ratio of each fruit fly species were recorded. The numbers of infested and uninfected fruits were recorded for all fruit species as well as percentage of infestation was also calculated.

III. Results and Discussion

Monitoring of Fruit Flies Using Liquid Food Bait

Ceratitis cosyra, Bactrocera invadens and B. cucurbitae were found in the study site (Fig II, Fig III, Fig IV respectively).Only the mango fruit fly *C.cosyra* was trapped by Nulure in the four experimental sites of Abugebeiha during the first season (2005/2006) while *Bactrocera invadens* and *Bactrocera cucurbitae* were captured in the second season (2006/2007). There was significant difference across locations with regard to the number of *C. cosyra* captured using Nulure Table I.

The highest fly catches were recorded in location one (20.25 ±3. 10), followed by location two (13.75±1.73), location three (10.62±1.45) and location four (7.75±0.67).The number of attracted females of *C. cosyra* was higher than males in all sites. This result is attributed to the potency of Nulure to attract females more than males because it contains protein hydrolyst that is highly required by females for egg maturity.The property of Nulue to attract *Ceratitis cosyra* indicating that *Ceratitis cosyra* is probably the most important species in mango plantation particulary in Abugubeiha, South Kordofan State. This result confirmed the hypothesis reported by [10] and [11] who stated that mango fruit fly (MgFF), *Ceratitis cosyra* is known to be the main pest of mango in Khartoum and Kassala States in Sudan. In the second season Nulure attracted *Ceratitis cosyra*, *Bactrocera invadens and B. cucurbitae*. The mean numbers of fruit fly species that were caught by Nulure were 21.2, 11.8 and 8.4 flies of *C. cosyra*, *B. cucurbitae* and *B. invadens*, respectively (Table 2. 4.3). No significant difference among locations was observed in the ability of Nulure to catch *C. cosyra* of both sexes. Mean number captured of *C.cosyra*, *B.invadens* and *B.cucurbita* was 21.2±2.39, 8.7 ±0.84, and 11.75±1.23 by Mcaphil trap baited with Nulure season 2006-2007 (Table II, Table III and Table IV). Nulure was found to attract *B. invadens* in all locations in the second season (2006/2007) but there was no significant difference among locations in the fly catches of *B. invadens*. The study showed that high number (106 flies/trap) of *Ceratitis cosyra* was captured by Mcphail trap baited with Nulure in the second season (2006/2007) followed by *Bactrocera cucucrbitae* (58.75flies/trap) and *Bactrocera invadens* (43.5 flies/trap) . This indicates that mango fruit fly, *Ceratitis cosyra* is the dominant species in the area of Abugubeiha. Similar results were reported by [12] who stated that mango fruit fly, *Ceratitis cosyra* is the dominant species in the area of Wad Medani and the Central region of the Sudan. The mean number of *C. cosyra* caught per trap per location was 4.85 and 4.10 for females and males, respectively. *B. invadens* frequently shared the same fruit with the indigenous fruit fly species, but often occurred at higher numbers. Although it was recorded and identified in Sudan in the very recent years [13], it seems that this species is spreading fast and replacing the already existed species. This result illustrates the phenomena of displacement of fruit flies to each other as a result of competition. This finding was supported by [14] who reported that *C. capitata* completely displaced *C. quinaria.* Then, *C. capitata* was replaced by *C. cosyra* which became the main dominant pest in many parts of the Sudan [12], [15] and [16]. In Kenya, [17] stated that within 4 years of invasion, *B. invadens* displaced *C. cosyra* and has become the predominant fruit fly pest of mango. [18] and [19] also reported that mangoes were readily attacked by *B. invadens* and that it was competing strongly with *Ceratitis cosyra*. These results are also supported by the finding of [13] who reported that the Asian fruit flies, *Bactrocera sp.,* are polyphagous and encounter interspecific competition with other polyphagous tephritid flies that are already well

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established. *B. species* were found to be the dominant species emerged from fruits infested with both fruit fly species, irrespective of which insect infested the fruit [20], [21] and [22], reported that the Asian fruit fly, *Bactrocera invadens* was able to displace *Ceratitis* flies, as observed in recent invasions.

Infestation levels

The results of the assessment of infestation levels by fruit fly species in mango, guava and grapefruit in Abugubeiha sites during seasons 2005/2006and 2006/2007 revealed that, during the first season the highest percentage of infestation was obtained from guava and mango (*Abusamaka cv.*) calculated (51%) and (31%), respectively while grapefruit recorded the lowest (18%) level of infestation. *Ceratits cosyra* was observed to emerge from mango, guava and grapefruit while *B. cucurbitae* was obtained from Mango. On other hand *Bactrocera invadens* was not emerged from mango, Guava and grapefruit during the first season. Guava was the most preferred host for *C. cosyra* than mango and grapefruit; 80, 59, 47 flies respectively. Females of *C. cosyra* was emerged in large number than males from guava, grapefruits while it was vice versa from mango. In mango, the males of *B. cucurbitae* were larger in number than females in the second season (2006/2007), *B. invadens* was observed for the first time to emerge from mango, guava and grapefruit. High infestation level by fruit fly species was noticed in the second season. *Ceratitis cosyra* was more common than *B. invadens* and *B. cucurbitae* in mango and guava. The population of *Ceratitis cosyra* revealed that females were found in great numbers than males in guava and mango while the dominance was for males of *Ceratitis cosyra* in fruits of grapefruit. The sex ratio of *Bactrocera cucurbitae* in mango revealed the supremacy of males more than females 13:8, respectively. The study proofed that males of *B. invadens* obtained from guava and grapefruit were more in numbers than females. The high percentage of infestation level in Guava during the two seasons (51% and 67%) when compared with mango (31% and 46%) and grapefruit (18% and 25%) is attributed to the early maturity of guava and the softness of its peel which is easily attacked by fruit fly . The increase in infestation level of mango (*Abusamaka cv.*) by fruit flies during the second season is attributed to the late collection of fruits in May 3 weeks later than the first season. This result agreed with the result obtained by [12] who stated that the percentage of infestation in mango (Abusamaka) increased rapidly from 31.7% in June to 62.5% in July and reached its peak (65.8%) in August, in Gezira State. This result was supported by [23] and [24] who reported *B. invadens* as polyphagous insect State and they detected it from many hosts in the River Nile State and Abugbeiha, South Kordofan. [25] also found that, *B. invadens* was the most prevalent species followed by *C. capitata* and *C. cosyra* in mango and guava in the Gezira area. [13] reported that *B. invadens* as highly invasive and possessing a wide range of host plants, cultivated and wild. However, the other 8 host plants (orange, grapefruit, banana, watermelon, snake cucumber, tomato, hot pepper and sweet pepper) showed no fruit flies during May-July. This might be due to the fact that the three species *B. invadens, C. cosyra* and *C. capitata* were highly selective to mango and guava. The present results match with studies in other African countries which show that the B. invadens primary or preferred hosts may vary according to the region, type and host availability [26]. Tropical sweet almond, guava and mango were the most favored and damaged host fruits, and they have already been mentioned as fruit flies most infested hosts [27], [28], [29], [30] , [31] Damage assessment done by [27] in Tanzania revealed highest percentage of damage on mangoes (61.7%), followed by guava (37.5%) and soursop (20%).In Kenya, [32] and [30] reported 58.3, 32.9, 27 and 31.4% of damaged fruits in mangoes, guava, tropical almond and sugar apple, respectively.

IV. Conclusion

Monitoring of Tephritidae Fruit flies in Abugubeiha area revealed the existence of three fruit fly species under the genus *Ceratitis* and *Bactrocera*. These are: Mango fruit fly, *Ceratitis cosyra*, The Melon fruit fly, *Bactrocera cucurbitae* and Asian fruit fly, *Bactrocera invadens*. The Mango fruit fly, *Ceratitis cosyra* is the dominant species in the area of Abugubeiha, South Kordofan State. Nulure food bait attractant proved to be effective bait for catching females of different fruit fly species. Usage of protein hydrolaste in lure and kill system is highly required in Sudan to decrease reliance on insecticides to control fruit flies. Among test attractants in this study, Nulure was found to be the best on trapping both sexes of various species of fruit flies dominate the three different ecological zones in Sudan. Authors would like to recommend the use of Nulure (two hundred and fifty ml of bait solution (Nulure (9%), borax (3%) and water (88%) in Mcphail trap to monitor and mass trapping fruit flies in Sudan.

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Previous publications:

1/ Mohammed E. E. Mahmoud*[1], Suliman A. Ibrahim[1], Hassbelrasul A. Mohamed [2] Recommendation of Cruiser 350 FS (Thiamethoxam) against the green bug *Schizaphis graminum* (Rondani) and termite on Wheat in 80th meeting of the national pests and diseases committee , June 2009 in Agricultural Research Corporation ,Wad Medani , Sudan.

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Table I. Mean number of Ceratitis cosyra captured by Mcphail trap baited with Nulure in Abugubeiha, Season 2005/2006.

Traps and Location	Female	Male	Total
T1 L1	10.25 ± 1.13a	10.0 ±2.04 a	20.25 ±3.10a
T2 L1	9.13 ±1.43a	7.13 ±1.20ab	16.25 a±2.12ab
T3 L2	7.75 ±1.21ab	6.00 ±0.95ab	13.75 ±1.73abc
T4 L3	6.12 ±1.06ab	4.50 ±0.71b	10.62 ±1.45c
T5 L4	3.88 ± 0.48b	3.88 ±0.48b	7.75 ±0.67c
Means/traps/location	7.43	6.30	13.73
SE±	0.59	0.62	1.09
C.V%	19.39	22.39	18.82
P	0.0008***	0.0008***	0.0003***

T1, T2, T3, T4 and T5 = Trap Number L 1, L2, L3 and L4 = locations
Means followed by a same letters are not significantly different at (P<0.01).

Table II: Mean number of males and females of Ceratitis cosyra captured by Mcphail trap baited with Nulure in Abugubeiha, Season 2006/2007.

Traps and Locations	Female	Male	Total
T1 L1	14.00 ±2.63	10.38 ±2.53	24.38 ±5.12
T2 L1	13.63 ±2.63	10.88 ±2.28	24.50 ±4.57
T3 L2	12.63 ±2.71	9.00 ±2.34	21.63 ±4.98
T4 L3	10.00 ±2.34	9.88 ±3.75	19.88 ±5.85
T5 L4	9.13 ±3.96	6.50 ±2.71	15.63 ±6.67
Means/traps/location	11.87	9.33	21.20
SE±	1.27^{ns}	1.20^{ns}	2.39^{ns}
C.V%	0.33	0.40	0.35

Ns = not significant T1, T2.T3, T4 and T5 = Trap number L 1, L2, L3 and L4 = locations

Table III: Mean number of males and females of Bactrocera invadens captured in Mcphail traps baited with Nulure in Abugubeiha. Season 2006/2007.

Trap and Location	Female	Male	Total
T1 L1	4.75 ±0.77	6.00 ±1.28	9.50 ±1.34
T2 L1	5.00 ±0.95	3.00 ±0.71	8.00 ±1.41
T3 L2	5.25 ±1.29	4.00 ±1.17	9.25 ±2.43
T4 L3	4.75 ± 1.26	4.38 ±0.93	9.12 ±2.03
T5 L4	4.50 ±1.33	3.13 ±1.01	7.63 ±2.31
Mean/traps/location	4.85	4.10	8.70
SE±	0.49^{ns}	0.47^{ns}	0.84^{ns}
C.V%	30.33	31.85	29.38
Sig	NS	NS	NS

Ns = not significant T1, T2.T3, T4 and T5 = Trap number L 1, L2, L3 and L4 = locations

Table IV. Mean number of males and females of Bactrocera cucurbitae Captured by Mcphail traps, baited with Nulure attractant in Abugubeiha. Season 2006/2007.

Traps and Location	Female	Male	Total
T1 L1	7.88 ±1.95	7.00 ±2.21	14.88 ±3.71
T2 L1	6.88 ±1.29	4.75 ±1.40	11.63 ± 5.78
T3 L2	6.00±1.78	5.50 ±1.17	11.50 ± 1.63
T4 L3	6.00 ±1.24	3.88 ± 0.95	9.87 ± 2.03
T5 L4	6.13 ± 2.18	4.75 ± 1.49	10.88 ± 3.57
Mean/Trap/location	6.58	5.18	11.75
SE±	0.68^{ns}	0.66^{ns}	1.23^{ns}
C.V%	31..25	38.32	32.75

ns = not significant T1, T2.T3, T4 and T5 = Trap number L 1, L2, L3 and L4 = locations

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Fig.I. Mcphail trap baited with Nulure placed on a mango

Fig.II. Mango fruit fly, *Ceratitis cosyra* (Walker) tree in Abugebeiha

Fig.III. Asian fruit fly, *Bactrocera invadens* (Drew)

Fig.IV. *Bactrocera cucurbitae*

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