Prospects of Using Aqueous Extracts of Maize, Sorghum and Millet to Lure Alien Invasive Tephritid Fruit Flies in Sudan

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Abstract

Tephritid Fruit Flies are the most economically important pests attacking fruits and vegetables worldwide reducing and hindered their exportation value. In Sudan, the problem of fruit flies exaggerated after the invasion of the country by the alien invasive species Bactrocera dorsalis in 2005 and B. zonata in 2012. This study focused on developing local food-based attractants to control fruit flies in guava ecosystem in two sites in Gezira State, Sudan. The study revealed the potency of aqueous extracts of sorghum (Sorghum bicolour), millet (Panicum sp) and maize (Zea mays)L to attract both sexes of B.zonata, B. dorsalis and Zeugodacus cucurbitae. The percentage of attracted females represented 70% of the total caught flies. Significant difference was observed at both study sites between different treatments on the number of females (P> F treat=0.0327) and total number of flies of B. zonata (P>F treat=0.0467) per trap per day. In the first site, Trula yeast attracted highest number of B. zonata/trap/day when compared to maize, millet and sorghum respectively, while aqueous extract of Maize was found to be the best among all other attractants in the second site. For B. dorsalis in the first site no significant differences was observed between treatments for females, males and total fruit flies/trap/day while high significant differences were observed between treatments for the caught numbers of males (p>F Treat = 0.0001), females (p>F Treat = 0.0001) and total number of flies/trap/day (p>F Treat = 0.0001) in the second site. Torula yeast attracted more flies of B. dorsalis than all other attractants followed by maize, millet and sorghum respectively. The presence of fruit flies all around the year on the guava ecosystem required non stopping control operations, thus, development of local attractants to reach the optimum levels are highly encouraged to reduce rely on insecticides.

Keywords: B.zonata, Attraction, Sorghum bicolour, Panicum sp

Introduction

Sudan has an enormous potentiality of horticultural production for the wide range of climatic conditions and diverse crops and ecosystems. Among many factors, Tephritid fruit flies are the main constraint that limit horticultural production and decrease the exportation value of the country. Due to the long borders with several neighbouring countries and its weak interception and quarantine procedures, Sudan is threatened by the invasion of exotic fruit flies from its long borders with several neighbouring countries and its weak interception and quarantine procedures.

The peach fruit fly, *Bactrocera zonata* (Saunders) native to South and South-East Asia. Now it is recorded in more than 20 countries. This pest can easily adapt and spread due to its polyphagy behaviour, high reproductive potential and high flight capacity. Peach fruit fly was first detected in Sudan in the Gezira State (Salah *etal.,* 2012), invaded and devastated different fruit causing over 60% fruit losses (Mahmoud *et al.*,2016). *B. zonata* attacks more than 50 host plants including guava, mango, peach, apricot, fig and citrus (Imran *et al*.,2013) but it is particularly a pest of peach, mango and guava (EPPO,2005).

Protein liquid attractants in insecticides spray is a recommended method to controlling adults fly populations in the vicinity of crops (Mahmoud *et al*., 2011), also food baits based on protein solutions, fermenting sugar solutions, fruits juices and vinegar have been used since 1918 to captures females of several species(Abdellah,2007).

Sudan with its vast and diverse horticultural and vegetables production zones avail produce of huge amounts of fruits and vegetables all around the year for local use and exportation. This production is hampered principally by fruit flies which reducing the quality and quantity of the produce and limiting the exportation capabilities. Thus, this study is initiated to formulate a package for the environmentally friendly control options of fruit flies since chemical insecticides have negative impact on the environment specially the beneficial organism.

This study aimed to develop local attractants with specific characters that can reduce the population of fruit flies and reduce the cost of control of fruit flies.

Materials and Methods

This study was conducted At Gezira state during the period of April to October 2016, to assess the attractiveness of water extracts of grains of maize (*Zea mays*), sorghum (*Sorghum bicolour*) and millet (*Panicum* sp.) to some species of fruit flies dominated the Gezira State compared to Trula yeast (the standard fruit fly attractant).An experiment was conducted in guava orchards at Fadasi and Gaziratalfil, Gezira stat, Sudan. The total area estimated in each

site was 5 Feddan. A randomized Complete Block Design (RCBD) with three replicates was used. At each site an experiment was repeated five times during five consecutive weeks.

Preparation of attractants

Grains of the three cereals were grinded to flour using the electric blinder. A weight of 8 grams of grinded maize, sorghum and millet were dissolved solely in 300 ml of water, the water extract of each plant material was put in McPhail trap. The same quantity of Trula yeast with the same volume of water was used for comparison. A weight of 7 grams of Borax (Disodium tetra borate) was added to each trap to preserve caught flies. The traps were hung on trees 1.5 to 2 metres above the ground. The distance between treatments was 6 metres a part and between replications was 12meters. Traps were serviced weekly, renewed and their positions were rotated randomly each week. Caught insects were placed in 70% Alcohol in plastic containers prior for identification, sorting out, sexing, counting and recording.

Statistical analysis:

Data in both experiments were subjected to analysis of variance (ANOVA) using SAS (2004) and means were separated using Tukeys range test also the effect of interaction between treatments and weeks was assessed. Data were transformed using the formula ($\sqrt{x + 0.5}$) when needed.

Results and Discussion

Aqueous extracts of Sorghum, Millet and Maize

Fadasi site:

According to the results, *B. zonata* and *B. dorsalis* were the main dominant species of fruit flies in this area. General performance of different attractants revealed that, the aqueous extract of maize, sorghum and millet have the ability to attract both males (29.9%) and females (71.1%) of both the above-mentioned species of fruit flies (Table,1).

Response of *B. Zonata* to attractants

As displayed in (Table1), significant difference was observed between different treatments on the numbers of females (P> F treat=0.0327) and total number of *B. zonata* (P> F treat=0.0467) per trap per day while highly significant difference was observed between weeks for the number of males, females and total *B. Zonata* (P>F week =<.0001). Highly significant differences were observed on the interaction between weeks and treatment for females (P> F week*Treat =0.0007) and total numbers of *B. zonata* (P> F week*Treat =0.001) (Table 1).

Trula yeast attracted the highest number of *B. zonata* (3.1 FTD) as well as highest number of females/trap/day (2.4FTD) followed by maize, millet and sorghum (Table,1).

Response of *B. dorsalis* to attractants

No significant difference was observed between treatments for females, males and total fruit flies/trap/day while highly significant differences were recorded between weeks and also between interaction of treatments and weeks. For the total number of fruit flies, significant difference (P>F treat=0.0228) was observed for number of (FTD) for different treatments. High significant difference was recorded between weeks (P> F weeks=<.0001) and significant difference was observed between interaction of treatments and weeks (P> F week*Treat =0.0125).

Gaziratalfil Site:

At Gaziratalfil, males and females of *B. zonata*, *B. dorsalis* and *Z. cucurbitae* were attracted to all test attractants.

Response of fruit flies to test attractants

1. ***B. zonata***

Highly significant difference was observed between different treatments on attraction of females (p>F Treat=0.0004) and total number of *B. zonata*/ trap/day (p>F Treat=0.0003). For both females and total numbers, Maize attracted the highest number of fruit flies/trap/day followed by Trula yeast, millet and sorghum with (1.3, 1.5), (0.6, 0.8), (0.5, 0.4) and (0.3, 0.4) respectively. The females represented 86.7%, 80.0%, 75.0% and 75.0% from the total *B. zonata* for the different treatment respectively.

Highly significant differences were observed between weeks and no significant differences were observed for the interaction between weeks and treatments. For males significant difference of treatments (p>F Treat = 0.0554) with same order was observed as above while high significant differences was recorded for numbers/trap/day for weeks (p>F weeks = 0.0034) and significant difference was observed between the interaction of treatments and weeks (P>F week*Treat=0.0325).

2. ***B. dorsalis***

High significant difference was observed between treatments for the caught numbers of males (P>F Treat = 0.0001), females (P>F Treat = 0.0001) and total number of *B. dorsalis*/trap/day (P>F Treat = 0.0001). The highest numbers of males, females and total fruit flies was attracted by Trula yeast followed by Maize, millet and sorghum respectively. The percentages of trapped females from the total number of *B. dorsalis* were 80.6%, 74.3%, 69.4% and 65.9% for the above-mentioned attractants respectively.

Significant difference was observed between weeks for males, females and total *B. dorsalis* while no significant difference was recorded for the interaction between treatments and weeks for both sexes and their total number/trap/day.

3. Zeugodacus cucurbitae

High significant difference was observed between treatments for the caught numbers of males (p>F Treat = 0.009), females (p>F Treat = 0.0003) and total number of *Z. Cucurbitae*/trap/day (p>F Treat = 0.0001). Maize gave the highest number of both sexes and total number followed by Trula yeast while both sorghum and millet gave same results. No significant was recorded for the interaction between treatments and interaction between treatments and weeks for both sexes and their total number/trap/day (Table 2)**.**

The results obtained in this study regarding trapping of fruit flies by using aqueous extracts of botanical origin; sorghum, millet and maize, to attract *B. zonata*, *B. dorsalis*, *D. vertebrauts* and *Z. Cucurbitae* were in agreement with the fact that adult fruit flies depend on fruit juices, extra floral glandular secretions, nectar from flowers, pollen grains, honeydew, bird faeces, and bacteria as main food sources (Prokopy,1976; Smith and Prokopy, 1981; Malavasi*et al*, 1983; Hendrichs and Hendrichs, 1990; Aluja and Birke, 1993;Warburg & Yuval, 1997, Manrakhan, 2005; and Basheir *et al.*, 2007).

Also in this study, the obtained results confirmed the potency of the sorghum, millet, maize to attract *B. zonata*, *B. dorsalis*, and *Z. Cucurbitae* were in agreement with different studies regarding usage of extracts of different plant materials to attract various fruit flies among these plants. Nulure and Trula yeast, Mazoferm, GF-120 and other protein hydrolysate derived from *Zea mays* are the most widely used food bait for trapping fruit flies in Europe, Mauritius and the United States (Mahmoud *etal*., 2017a; Heath *etal.*, 1993; Beije *etal.*, 1997).

The food attractants used in this study obtained high catches of females which considered as an advantage which is in accordance with (Heath *etal*., 1993) who stated that food baits capture both sexes, with a bias towards females.

Cucumber, when mixed with water or vinegar and yeast can attract both sexes of *Z. cucurbitae* (Russel, 1990). Also, Bashir *et al*., (2007) stated that water extracts of mango (*Mangifera indica*), guava (*Psidium guajava*),

and Sidir (*Zizyphus spinachristi*) attract *C. cosyra*. Also Mahmoud etal 2012 reported that, B. dorsalis, C. cosyra C. capitata and Z. Cucurbitae are highly attracted to water extract of apple, mango, guava and cucumber and some readymade juice of some other fruits

Recommendation

Food based attractants are among the most environmentally safe options for controlling fruit flies. To initiate environmentally sound containment for alien invasive fruit flies authors would like to recommend the use of water extract of Maize, Sorghum and Millet at 8 gram diluted in 300 ml water for each in McPhail traps for trapping of *B. zonata*, *B.dorsalis* and *Z. Cucurbitae* for their simplicity and affordability and cost effective as local materials.

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Table 1. Mean number of fruit flies/trap/day attracted to aqueous extracts of sorghum, millet and maize on guava orchard at Fadasi from 18/4 to 16/5/2016,(combined analysis of five weeks).

Treatment	Fruit Flies/Trap/Day						Total ff
	B. zonata			*B. dorsalis*			
	M	F	T	M	F	T	
Maize	0.8	2.1 a	2.8 a	0.2	0.04	0.2	3.1 ab
Sorghum	0.4	0.9 b	1.2 ab	0.0	0.0	0.0	1.2 b
Millet	0.6	1.4 b	2b	0.0	0.04	0.1	2.2 b
Trula yeast	0.7	2.4 a	3.1 a	0.15	0.3	0.5	3.6 a
CV%	14.9	21.5	23.8	13.2	12.7	20.2	27
P>F week	<.0001	<.0001	<.0001	0.0017	0.0036	0.0007	<.0001
P>F treat	0.1882	0.0327	0.0467	0.5499	0.1058	0.2971	0.0228
P>Fweek*Treat	0.0156	0.0007	0.001	0.7452	0.03	0.2791	0.0125

Means in the same columns followed by the same letter (s) are not significantly different at ($P \leq 0.05$) according to TMRT. Data transformed to $\sqrt{x + 0.5}$.

Table 2. Mean number of fruit flies/trap/day attracted to water extract of Sorghum, Millet and Maize in guava orchard at Gaziratalfil 29/9 to 27/10/2016 (combined five weeks).

Treatment	Mean number of males, females and total fruit flies/trap/day									Total FF
	B. zonata			*B. dorsalis*			*Z. cucurbitae*			
	M	F	T	M	F	T	M	F	T	
Maize	0.2 aa	1.3 a	1.5 a	1.9 ab	5.2 a	7 a	0.1	0.2	0.3 a	8.9 a
Sorghum	0.1 b	0.3 b	0.4 b	1.1 b	2.5 b	3.1 b	0.04	0.03	0.1 b	3.6 b
Millet	0.1 ab	0.4 b	0.5 b	1.1 b	2.5 b	3.6 b	0.05	0.02	0.1 b	4.5 b
Torula	0.1 ab	0.6 b	0.8 b	3 a	5.8 a	8.8 a	0.1	0.1	0.2 ab	9.9 a
C.V%	5.3	16.3	17.1	21.1	18.1	20.6	4.5	4.2	7.2	20.3
P>F week	0.0034	0.0075	0.0058	0.0023	0.0156	0.048	0.107	0.1427	0.1247	0.0163
p>F Treat	0.0554	***0.0004	***0.0003	***0.0007	***0.0001	***0.0001	***0.009	***0.0003	***0.0007	***<0.0001
P>Fweek*Treat	0.0325	0.8219	0.8725	0.4775	0.3611	0.3747	0.2411	0.1569	0.2619	0.4347

Means in the same columns followed by the same letter (s) are not significantly different at ($P \leq 0.05$) according to TMRT. Data transformed to $\sqrt{x + 0.5}$.