Effect of Traps Directions on the Density of the Peach Fruit Fly, *Bactrocera zonata* in Gezira State, Sudan

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Abstract

Fadul, R.E.H., F.E.E. Salah, H. Abdelgader, A.A. E. Omer and A.B. Dafaallah. 2025. Effect of Traps Directions on the Density of the Peach Fruit Fly, *Bactrocera zonata* in Gezira State, Sudan. Arab Journal of Plant Protection, 43(1):137-142. https://doi.org/10.22268/AJPP-001284

In Sudan, the production of horticultural crops is affected by fruit flies (*Bactrocera* spp.) that may play a major role in reducing production and limiting the exportation capabilities. The objective of the present study was to investigate the effect of trap direction on the density of peach fruit fly, *Bactrocera zonata* in Gezira State, Sudan during 2016/2017 growing season. Three locations were selected in the study area and three sites were selected at each location. An orchard was randomly selected at each site and five directions for each orchard were determined. Methyl Eugenol trap was used to estimate the seasonal abundance of the fly among locations, sites and directions. Data were subjected to descriptive analysis and regression analysis. There were significant ($P \leq 0.05$) differences in the density of the fruit fly (*Bactrocera zonata*) among the directions in Alkamleen location. However, there were no significant differences in the density in Wad Medani and Elhagabdallah, Gezira State locations during the 2016/2017 growing season. In general, the highest density of the insect (13.14 insects per trap) was recorded in the west direction followed by the east direction (12.74 insects per trap), south direction (10.39 insects per trap) and center direction (10.11 insects per trap), whereas the lowest density (8.74 insects per trap) of the insect was recorded in the north direction. These findings could be useful in monitoring fruit flies (*Bactrocera* spp.) in the agro-ecological system of Gezira State, Sudan.
Keywords: Abundance, *Bactrocera*, direction, methyl eugenol, fruit fly.

Introduction

Horticulture production is one of the most important agricultural subsectors in Africa, providing income, creating employment opportunities, and enhancing food and nutritional security (Mafirakurewa, 2014). Sudan has a vast and diverse fruit and vegetable production zones which enable production of horticultural crops all around the year (Mahmoud *et al.*, 2012). The peach fruit fly, *B. zonata* (Saunders) is one of the most serious Tephritid insect pests attacking tropical and subtropical fruits. This pest was originally reported from India, firstly from the Bengal region. It is now widespread over India, Pakistan, Nepal, Bangladesh, Sri Lanka, Minmar and evidently over southeast Asia. (Choudhary *et al.*, 2015). Hosni *et al.* (2011) reported its presence in more than 20 countries. *B. zonata* is a serious and polyphagous pest of peach and custard apples in India (Ni *et al.*, 2012). It is present in numerous countries of tropical Asia (Rehman *et al.*, 2009). Tephritidae consists of over 4300 species, of which nearly 700 species belonging to Dacine fruit flies (Dhillon *et al.*, 2005; Mahmoud *et al.*, 2012), whose representatives are known to attack different types of commercial and wild fruits and vegetables causing considerable yield loss (De Meyer *et al.*, 2014; Fetoh, 2012; Sarwar *et al.*, 2013).

Sudan has already been invaded with the most devastating Asian species, *B. invadens* (Drew *et al.*, 2005). It is also threatened by the invasive fruit fly, *B. zonata* through its northern border with Egypt. Rwomushana *et al.* (2008) assessed the host range of the invasive fruit fly, *B invadens* in 90 cultivated and wild host plants, 14 plants out of them were found to be host of *B. invadens. B. zonata* attacks more than 20 host plants (White & Elson-Harris, 1992). In Sudan, fruit flies (*Bactrocera* spp.) were first detected in 2012 (Salah *et al.*, 2012) in Wad Medani area, Gezira State, where it invaded different fruits causing over 60% fruit losses (Mahmoud *et al.*, 2020). *B. zonata* attacks more than 50 host plants, including guava, mango, apricot, fig and citrus (Imran *et al*., 2013), but it is particularly a pest of peach, mango and guava (EPPO, 2005). It was also reported to attack various fruits and vegetables in laboratory studies among them is date palm which represent the major cash crop for the Northern and River Nile State in Sudan (Mahmoud *et al.*, 2012). Fruit flies (*Bactrocera* spp.) are probably the most serious cause of losses to many types of fruits and vegetables (Mafirakurewa, 2014). The fruit flies play a major role in reducing production and limiting the possibility of exportation. The situation of horticultural production in Sudan has been aggravated since the country was invaded by the last two alien invasive species (*B. zonata* (Saunders) and *B. invedens* (Drew) (White & Elson-Harris, 1992).

Owing to their high reproductive capacity coupled with the lack of competitors and efficient natural enemies of *B. zonata* and *B. invedens*, and further compounded with the poor quarantine infrastructure in the African countries, the pests have continued to spread at an alarming rate across different regions, with far reaching socioeconomic consequences. The Trans-regional invasions by these alien invasive pests require a consolidated and systematic region-wide approach for their early detection and management (Mohamed *et al*, 2012). Due to the development of trade

https://doi.org/10.22268/AJPP-001284

exchange in the world, many countries became more vulnerable to some exotic species of flies that may find the appropriate conditions to their dispersion in the absence of a diagnosis and surveillance system.

This study was conducted in the Gezira State, Sudan during season 2016/2017 to investigate the effect of trap direction on the density of fruit fly, *Bactrocera zonata* (Diptera: Tephritidae) in Gezira State, Sudan.

Materials and Methods

Study area

This study was conducted in the Gezira State, central Sudan. The state lies between the Blue Nile and the White Nile in the east-central region of the country 14°24 ′N -33°31′ E. It has an area of 27,549 km .The climate of the study area is semi-desert with a mean annual precipitation of 100-250 mm/year, with the rainy season extended from June to October and the dry season from March to June. The mean annual evapotranspiration is 2400 mm/year. The mean annual minimum and maximum temperatures are 12°C in January and 42°C in May, respectively. The soil of the area is characterized by heavy clay soil (clay 60%), with pH 8-8.5, low organic matter and nitrogen content, adequate potassium and low available phosphorus (Elbasher *et al*., 2023).

Field surveys

Several field surveys were conducted in the study area during the 2016/17 season. Three locations were selected in the study area; Alkamleen in the north, Wad Medani in the middle and Alhag abdulla in the south. At each location, three sites were selected; Abdullah, Mashtal and Hamra were selected at Alkamleen. Atra, Geziratefeel and Umsunt were selected at Wad Medani, and Denegila, Abusogra and Santibar at Alhagabdalla. At each site an orchard was randomly selected and at each orchard five directions were determined *i.e*. north, east, south, west and center, where insect traps were placed. In the orchards, different types of horticultural crops such as guava, mango, citrus and vegetables were grown.

Effect of directions on the density of fruit fly, *Bactrocera zonata* in different locations

To study the effect of directions on the density of fruit fly, *B. zonata* in different areas in the Gezira State, Sudan during the 2016/2017 growing season. The population density of the fruit fly was estimated in all locations, sites and directions. Five traps were placed in each direction in each mango or guava orchard. The trap was made from plastic container with two lateral openings and contained a piece of cotton fiber supplied with the pheromone methyl eugenol and the insecticide Malathion (4:1 in cotton swabs). One trap per mango or guava tree was hanged on the branches of the tree at one-meter-high distance from the ground. The insects attracted in each trap were collected in plastic containers and transferred to the laboratory to determine the density of the insect and for the identification of the fruit fly species. The traps were supplied with Methyl Eugenol and Malathion monthly, the collection and identification were recorded monthly for 12 months starting from January 2016 to December 2016. The identification of the insect was made by the Insect Taxonomy Unit, Crop Protection Center, Agricultural Research Corporation (ARC), Sudan.

Statistical analysis

Data were subjected to descriptive analysis and analysis of variance (ANOVA). The significance between means was determined by using Duncan's multiple range test at P=0.05. Statistical analysis was performed using the software STATISTIX 8 and Excel software.

Results and Discussion

Effect of direction on the density of fruit fly, *Bactrocera zonata*

The results obtained showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions in Alkamleen. However, there were no significant differences in the density in Wad Medani and Elhagabdallah, Gezira State, Sudan during the 2016/2017 growing season. There were no significant differences in the density of the fruit fly (*B. zonata*) among the directions in Wad Medani, Gezira State, Sudan during the 2016/2017 season (Table 1). However, the highest density (20.33 insects per trap) of the insect was recorded in the east direction followed by the center (13.93 insects per trap) and west (13.70 insects per trap) directions, whereas the lowest density (9.83 insects per trap) of the insect was recorded in the north and south (9.50 insects per trap) directions.

These findings were in agreement with those of Gaperallah *et al.* (2013) who found that the east direction recorded the highest fruit fly, *B. zonata* infestation among the four directions, followed by the north direction. However, Hashem *et al.* (2003) found that the west direction was the best position for placing Jackson traps among the four main directions and field Center to trap the highest significant number of fruit fly males, followed by north, center, east and south directions

The results obtained also showed that there were no significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Elhagabdallah, Gezira State, Sudan, during the 2016/2017 season (Table 1), and the highest density (0.23 insects per trap) was recorded in the north, east and south directions, whereas the lowest density (0.10 insects per trap) was recorded in the west direction followed by the center direction (0.13 insects per trap). These findings were consistent with those reported by Abbas (2018) who found that for Guava trees the infestation rate by *B. zonata* was significantly higher in the north side compared to the other sides, through the seasons. The other side's direction harbored moderate levels of infestation. Abbas (2018) concluded that directions and fruit distribution on trees plays an important role in infestation rate by *B. zonata* on guava, and the peach fruit fly *B. zonata* prefer the east-north direction. Thus, for monitoring purposes, the east-north direction of the orchard may be the most suitable location to hang traps on the trees.

The results obtained also showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the different directions in Alkamleen,

Gezira State, Sudan during the 2016/2017 season (Table 1). The density (25.63 insects per trap) in the west direction was significantly higher compared to the north, east and center directions. There was no significant difference in the density of the insect between west and south directions.

In general, there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions in Alkamleen. However, there were no significant differences in the density in Wad Medani and Elhagabdallah, Gezira State, Sudan during the 2016/2017 season. In general, the highest density of the insect (13.14 insects per trap) was recorded in the west direction followed by the East direction (12.74 insects per trap), South direction (10.39 insects per trap) and Center direction (10.11 insects per trap), whereas the lowest density (8.74 insects per trap) of the insect was recorded in the North direction.

Regardless of direction and time, the results obtained showed that the highest density (19.4 insects per trap) of the fruit fly was scored at Alkamleen followed by Wad Medani (13.5 insects per trap). However, Alhagabdallah scored the lowest density (0.2 insects per trap) of the insect. The high density of the insect in Alkamleen may be attributed to the existence of the different hosts such as mango, guava, banana, citrus, vegetables and others, in addition to the large area of the orchards.

Effect of directions on the density of fruit fly, *Bactrocera zonata* at different sites at Wad Madani location

The results obtained showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly (*B. zonata*) among the different directions at Atra, Wad Medani, Gezira State, Sudan during season 2016/2017 (Table 1). The density (7.3 insects per trap) of the insect in the North direction was significantly higher than in the west and center directions. There were no significant differences in the density of the insect between north, east, south and center directions. However, the west direction showed significantly the lowest density (3.2 insects per trap). There were no significant differences in the density of the insect between east, south and center directions.

The results obtained showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Umsunt location, Wad Medani, Gezira State, Sudan during the 2016/2017 growing season (Table 1). The insect density (4.1 insects per trap) in the north direction was significantly higher than that of the south direction. In addition, there was no significant difference in the insect density between north, east, west and center directions. However, the south direction showed significantly the lowest density (2.3 insects per trap). There was no significant difference in the density of the insect between east, west and center directions.

The results showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Gaziratelfeel location, Wad Medani, Gezira State, Sudan, during the 2016/2017 season (Table 1). The insect density (50.3 insects per trap) in the east direction was significantly higher than that in the north and south directions. There was no significant difference in the insect density between east, west and center directions. However, the North direction showed significantly the lowest insect density (18.1 insects per trap). There was no significant difference in the insect density between north, south, west and center directions.

Table 1. Effect of trap directions on the density of fruit fly, *Bactrocera zonata* in different sites at Gezira State, Sudan during the 2016/2017 growing season.

	Mean number of insects/trap						
Direction	**North**	**East**	**South**	**West**	**Center**	**SE**	**CV%**
Gezira State/Main locations							
Wad Medani	3.10 (9.83)	4.00 (20.33)	2.86 (9.50)	3.30 (13.70)	3.47 (13.93)	0.53	19.36
Alhagabdallah	0.85 (0.23)	0.85 (0.23)	0.85 (0.23)	0.77 (0.10)	0.79 (0.13)	0.05	7.26
Alkamleen	3.83 (16.17)	3.99 (17.67)	4.43 (21.43)	7.73 (25.63)	3.68 (16.27)	0.32	9.30
Mean	8.74	12.74	10.39	13.14	10.11	2.9	32.2
Gezira State/Wad Medani region							
Atra	2.24 (7.3)	1.96 (5.4)	1.83 (4.2)	1.6 (3.2)	2.20 (6.3)	0.26	32.85
Umsunt	1.44 (4.1)	1.09 (5.3)	0.96 (2.3)	1.17 (4.0)	1.09 (4.2)	0.21	44.23
Gazirat-Elfeel	3.94 (18.1)	6.12 (50.3)	4.44 (22.0)	5.27 (33.9)	5.04 (31.3)	0.71	34.94
Mean	3.10 (9.83)	4.00 (20.33)	2.86 (9.50)	3.30 (13.70)	3.47 (13.93)	0.53	19.36
Gezira State/Elhagabdallah region							
Sntibar	0.1 (0.74)	0.1 (0.74)	0.1 (78)	0.1 (0.75)	0.1 (0.75)	0.05	15.33
Abusogra	0.5 (0.93)	0.3 (0.88)	0.3 (0.88)	0.1 (0.77)	0.2 (0.81)	0.0	23.37
Aldenigila	0.1(0.79)	0.3 (0.83)	0.3(0.83)	0.1(0.77)	0.1 (0.77)	0.08	24.4
Mean	0.23 (0.85)	0.23 (0.85)	0.23 (0.85)	0.10 (0.77)	0.13 (0.79)	0.05	7.26
Gezira State/Alkamleen region							
Hamra	2.44 (7.5)	2.33 (9.1)	3.05 (12.8)	2.37 (8.0)	2.09 (5.6)	0.31	30.72
Alabdallab	5.14 (33.5)	5.40 (36.6)	5.93 (42.6)	6.68 (54.5)	5.65 (38.0)	0.53	22.57
Almashtal	2.45 (7.5)	2.49 (7.3)	2.66 (8.9)	3.38 (14.4)	2.19 (5.2)	0.46	43.30
Mean	3.83 (16.17)	3.99 (17.67)	4.43 (21.43)	7.73 (25.63)	3.68 (16.27)	0.32	9.30

Data between two brackets are a $\sqrt{x + 0.5}$ transformation.

In general, the results showed that there were no significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the different directions at Wad Medani, Gezira State, Sudan during the 2016/2017 season (Table 1). However, the highest insect density (20.33 insects per trap) was recorded in the east direction followed by center (13.93 insects per trap) and west (13.70 insects per trap) directions, whereas the lowest insect density (9.50 insects per trap) was recorded in the south direction followed by the north direction. Regardless of direction and time, the results showed that the highest density (19.4 insects per trap) of the fruit fly was found at Gaziratelfeel location. However, the lowest insect density (3.98 insects per trap) was found at Umsunt location, followed by Atra location (5.28 insects per trap).

Effect of directions on the density of fruit fly, *Bactrocera zonata* in different sites at Elhagabdallah location

The results showed that there were no significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions in Sntibar, Elhagabdallah, Gezira State, Sudan during season 2016/2017 (Table 1). The density of the insects in the north, east, south, west and center directions was 0.1 insects per trap.

The results showed that there were no significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Abusogra, Elhagabdallah, Gezira State, Sudan during season 2016/2017 (Table 1). However, the highest density (0.5 insects per trap) of the insect was recorded at the north direction, while the lowest density (0.1 insects per trap) of the insect was recorded in the west direction. The results showed that there were no significant ($P \leq 0.05$) differences in the density of the fruit fly (*B. zonata*) among the directions at Aldenigila, Elhagabdallah, Gezira State, Sudan during season 2016/2017 (Table 1). However, the highest density (0.3 insects per trap) of the insect was recorded at the east direction, whereas the lowest density (0.1 insects per trap) of the insect was recorded in the north, west and center directions.

In general, the results showed that there were no significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the different directions at Elhagabdallah, Gezira State, Sudan during the 2016/2017 season (Table 1). However, the highest density (0.23 insects per trap) was recorded at the north, east and south directions, whereas the lowest density (0.10 insects per trap) of the insect was recorded in the west direction, followed by center direction (0.13 insects per trap). Regardless of direction and time, the results showed that the highest density (0.28 insects per trap) of the fruit fly was scored in Abusogrra followed by Aldenigila (0.18 insects per trap) and Santibar (0.1 insects per trap) sites.

Effect of directions on the density of fruit fly, *Bactrocera zonata* in different sites, Alkamleen location

The results obtained showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Hamra, Alkamleen, Gezira State, Sudan during the 2016/2017 season (Table 1). The density (12.8 insects per trap) of the insect in the South direction was significantly higher compared to the density of the insect in the east, west and center directions. There was no significant difference in the density of the insect between north and south directions. In addition, there was no significant difference in the insect density between north, east, west and center directions. However, the center direction recorded significantly the lowest density (5.6 insects per trap).

The results showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Alabdallab, Alkamleen, Gezira State, Sudan during season 2016/2017 (Table 1). The density (54.5 insects per trap) of the insect in the west direction was significantly higher compared to the density of the insect in the north and east directions. There was no significant difference in the density of the insect between south, west and center directions. However, the north direction recorded significantly the lowest density (33.5 insects per trap). There was no significant difference in the density of the insect between north, east, south and center directions. The results also showed that there were no significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Almashtal, Alkamleen, Gezira State, Sudan during the 2016/2017 season (Table 1). However, the highest density (14.4 insects per trap) of the insect was recorded at the west and south directions, whereas the lowest density (5.2 insects per trap) of the insect was recorded in the center.

In general, the results showed that there were significant ($P \leq 0.05$) differences in the density of the fruit fly, *B. zonata* among the directions at Alkamleen, Gezira State, Sudan during season 2016/2017 (Table 1). The density (25.63 insects per trap) of the insect in the west direction was higher compared to the density in the north, east, south and center directions. However, there was no significant difference in the insect density between south and west directions. The density of the insect (16.27 insects per trap) in the center direction was the lowest. Regardless of direction and time, the results obtained showed that the highest density (41.04 insects per trap) of the fruit fly was scored at Alabdallab. However, Hamra site scored the lowest density (8.6 insects per trap) of the insect followed by Almashtal site (8.66 insects per trap).

It can be concluded from this study that there were significant differences in the density of the fruit fly, *Bactrocera zonata* among the directions in Alkamleen location. However, there were no significant differences in the density in Wad Medani and Elhagabdallah locations, Gezira State, Sudan during the 2016/2017 season. In general, the highest density of the insect (13.14 insects per trap) was recorded in the west direction followed by the east direction (12.74 insects per trap), south direction (10.39 insects per trap) and center direction (10.11 insects per trap), whereas the lowest insect density (8.74 insects per trap) was recorded in the north direction. These findings could be utilized in improving monitoring accuracy of fruit flies, *Bactrocera* spp. in the agro-ecological system of Gezira State, Sudan.

الملخص

فضل، رحاب الكامل حسن، فائزة الجيلي الحسن صلاح، حيدر عبد القادر، أحمد آدم عيسى عمر وعوض الله بلال دفع الله. 2025. تأثير اتجاهات المصائد في كثافة ذبابة الخوخ (*Bactrocera zonata*) في ولاية الجزيرة، السودان. مجلة وقاية النبات العربية، 43(1):137−142.

https://doi.org/10.22268/AJPP-001284

تتأثر زراعة الفاكهة في السودان بحشرات ذباب الفاكهة (*Bacterocera* spp.) التي تلعب دوراً رئيساً في تقليل الإنتاج والحدّ من إمكانيات التصدير. هدفت هذه الدراسة إلى تقييم تأثير اتجاه المصائد في الكثافة الموسمية لذبابة الخوخ (*Bactrocera zonata*). أُجريت عدة مسوحات ميدانية في ولاية الجزيرة، السودان خلال موسم 2017/2016، حيث أُختيرت ثلاث مناطق وثلاثة مواقع في كل منطقة لإجراء الدراسة. أُختير بستانٌ واحد عشوائياً في كل موقع، وحدّدت خمسة اتجاهات في كل بستان. استخدمت مصيدة ميثيل الأوجينول (Methyl Eugenol trap) لتقدير كثافة ذبابة الخوخ (*Bactrocera zonatas*) في المناطق والمواقع والاتجاهات. خضعت البيانات للتحليل الوصفي وتحليل الانحدار. قورنت المتوسطات لتحديد المعنوية عند مستوى احتمال 5%. أظهرت النتائج أن هناك ثمّة فروقات معنوية في كثافة ذبابة الخوخ (*Bactrocera zonata*) في موقع الكاملين ولا توجد فروقات معنوية في ود مدني والحاج عبد الله بولاية الجزيرة خلال الموسم الزراعي 2017/2016. بلغت الكثافة العددية للحشرات أعلاها في الاتجاه الغربي (13.14 حشرة/مصيدة)، تلاها الاتجاه الشرقي (10.11.حشرة/مصيدة)، بينما سُجلت أقلّ كثافة في اتجاه الشمال (8.074 حشرة/مصيدة). يمكن الاستفادة من نتائج هذه الدراسة في تقييم كثافة ذبابة الخوخ (*Bactrocera zonata*) في النظام الزراعي البيئي لولاية الجزيرة، السودان.

كلمات مفتاحية: الكثافة العددية، ذباب الفاكهة، الاتجاهات، ميثيل الأوجينول.

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Received: September 8, 2023; Accepted: December 6, 2023

تاريخ الاستلام: 2023/9/8؛ تاريخ الموافقة على النشر: 2023/12/6