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Original Research Article

Effect of Trap Color, Cultural and Sanitation Measures on Density of Fruit Fly, *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) in Gezira State, Sudan

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Abstract: Fruit flies, *Bactrocera* spp., are among the most destructive fruit/vegetable- eating agricultural pests in the world, particularly in African countries such as Sudan. The objective of this study was to investigate the effect of trap color, cultural and sanitation measures on density of the peach fruit fly *Bactrocera zonata* (Saunders) (Diptera: Tephritidae). Several field surveys were conducted in the Gezira State, Sudan during the 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 at each orchard were determined. Methyl eugenol trap was used to estimate the effect of trap color, cultural and sanitation measures on the population density of the fruit flies. Data were subjected to descriptive analysis and analysis of variance. The results obtained showed that during the flowering period of mango, peach fruit fly was highly attracted to other colors rather than the yellow color, whereas, during fruiting the insect was highly attracted to the yellow color compared to the other colors. The density of the insects was significantly lower in the well managed orchards (8.7 insects per trap per week) compared to the poor managed orchards (36.9 insects per trap per week). Accordingly, the trap color, composition of the horticultural crop, proper cultural practices and good sanitation measures are factors need to be addressed when considering peach fruit fly control.

Keywords: *Bactrocera Zonata*, Color, Methyl Eugenol, Peach Fruit Fly, Sanitation.

INTRODUCTION

Horticulture is one of the most important agricultural sub-sectors in Africa, providing income, creating jobs and enhancing food and nutrition security (Mafirakurewa, 2014). Sudan has vast and diverse horticultural and vegetable production areas that enable year-round production of fruits and vegetables (Mahmoud *et al*., 2012). The fruit flies belonging to Diptera: Tephritidae, are among the most important pests that cause damage to fruit crops such as mango, guava, citrus and some vegetables (Mahmoud *et al*., 2012). These pests cause significant crop losses that include direct damage to production and a high control cost. These pests also limit access to potential foreign markets as strict quarantine measures for this pest are implemented by many countries.

The family Tephritidae contains 4000 species throughout the world (Fletcher, 1987) and out of 4000 species there are 44 species from genus *Bactrocera* which are important agricultural pests and are distributed in tropical, subtropical and temperate regions of the world (Kapoor, 2008). In Sudan, fruit flies (*Bactrocera* spp.) were first detected in 2012 (Salah *et al.,* 2012) in Wad Medani area, Gezira State, to invade different fruits causing over 60% fruit losses (Mahmoud *et al.,* 2016). *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 the fruit of 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 situation of horticultural production in Sudan has been aggravated since the country was invaded by the last two alien

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invasive species *Bacrocera zonata* (Saunders) and *Bactrocera invedens* (Drew) (White and Elson Harris, 1992).

It is important to develop some control strategy that must be economically and ecologically compatible. Among the various tools used for the control of fruit flies, the use of different color traps is considered one of the effective strategies of IPM that help farmers to detect and control fruit flies at preliminary stages. In addition, management practices such as orchard sanitation, weed control, application of bait sprays, hoeing under the canopy and picking and burying of dropped fruits are important pest management components in citrus orchards (Sikandar *et al*., 2017).

This study was conducted in the Gezira State, Sudan during season 2016/2017 to investigate the effect of trap color, cultural and sanitation measures on population density of peach fruit fly, *Bactrocera zonata* (Saunders) (Diptera: Tephritidae).

Materials and Methods Study Area

This study was conducted in Wad Medani area, Gezira State, central Sudan. The climate of the study area is semi-desert with a mean annual precipitation of 100-250 mm, 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, adequate potassium and low available phosphorous (Elbasher, 2016).

Field Surveys

Several field surveys were conducted in the study area during the 2016/17 growing season. Three sites were selected: Atra, Umsunt and Geziratefeel. At each site an orchard was randomly selected and for each orchard five directions were determined *i.e.* North, East, South, West and Center. In the orchards, different types of horticultural crops such as guava, mango, citrus and vegetables were grown.

Effect of Color on Density of Fruit Fly (*Bactrocera Zonata*) In Different Directions in the Gezira State, Sudan during the 2016/2017 Season

To study the effect of color on the population density of fruit fly (*B. zonata*) in different directions in the Gezira State, Sudan during the 2016/2017 season, a selected mango orchard at Hantoob site at Wad Medani area was surveyed. Five traps were placed in each direction of the mango 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 swaps). Five different colored traps were used. The five colors were white, red, yellow, green and blue. One trap per mango tree was hanged on the branches of the tree at one-meter-high above ground. The insects attracted in each trap were collected in plastic containers and transferred to the laboratory to count the insect numbers and for the identification of the fruit fly species. The traps were supplied with methyl eugenol and malathion monthly, and the counting and identification were made monthly for 12 months starting from January to December, 2016. The identification of the insect was made by the Insect Taxonomy Unit, Crop Protection Center, Agricultural Research Corporation (ARC), Sudan.

The Abundance of the Fruit Fly (*Bactrcera Zonata*) In the Gezira State, Sudan during 2016/2017 Season

To study the abundance of the fruit fly (*B. zonata*) in the Gezira State, Sudan during the 2016/2017 season, the population density of the fruit fly was estimated at all locations and sites. Five traps were put in each direction in each mango or guava orchard. Insect traping, counting and identification were made as described above.

Effect of Cultural and Sanitation Measures on Fruit Fly (*Bactrocera Zonata*) Density in Different Sites in the Gezira State, Sudan During the 2016/2017 Season

Six well managed and six poorly managed orchards were selected at Atra, Hantoub and Gazirat Elfeel sites at Wad Medani location. The same traps described above were used. The fruit fly species collected were recorded weekly for three months, from March to May, 2017.

Statistical Analysis

Data were subjected to analysis of variance (ANOVA). Means significant ($P \leq 0.05$) were separated using Duncan's multiple range test. Statistical analysis was performed using the software STATISTIX 8 and Excel software.

RESULTS AND DISCUSSION

Effect of Color on Density of Fruit Fly (*Bactrocera Zonata)* in Different Areas in the Gezira State, Sudan during 2016/2017 Season

The results showed that there were no significant ($P \leq 0.05$) differences in the population density of the fruit fly (*Bactrocera zonata*) attracted by the different colors at north direction in Wad Medani, Gezira State, Sudan during the 2016/2017 season (Table 1). However, the yellow traps in the north direction and the white traps in the east direction attracted the highest number of the insect. The corresponding density of the fruit fly was 6. 17 and 8.25 insects per trap in the north and east directions, respectively. Whereas, the green traps in the north direction and the blue traps in the east direction attracted the lowest number of the insect. The corresponding density of the fruit fly was 3.33 and 4.08 insects per trap in the north and east directions, respectively.

Table 1: Effect of color on population density of the fruit fly (*Bactrocera zonata*) at different directions in the Gezira State, Sudan during the 2016/ 2017 growing season

Trap color	Mean number of insects/trap					Mean
	North	East	South	West	Center	
While	(5.75) 2.17	(8.25|) 2.54	(8.42) 2.67 a	(9.25) 2.55 a	(4.83) 1.89ab	7.27 a
Red	(5.00) 1.91	(5.5) 1.86	(3.66) 1.60 b	(4.83) 1.94 ab	(2.58) 1.45 b	4.32 b
Yellow	(6.17) 2.18	(4.83) 1.89	(10) 2.74 a	(5.67) 2.26 ab	(4.58) 1.89 ab	6.40 ab
Green	(3.33) 1.75	(5.33) 1.20	(7.5) 2.28 ab	(4.83) 2.04 ab	(10.0) 2.51 a	6.20 ab
Blue	(3.83) 1.67	(4.08) 1.86	(7.75) 2.52 a	(4.83) 1.91 b	(5.25) 1.88b	5.15 ab
SE ±	0.35	44.30	0.41	0.32	0.31	1.22
CV %	44.31	0.37	42.88	36.20	39.98	32.95

* Data between parentheses are transformed to$\sqrt{x} + 0.5$

** Means in the same column followed by the same letter(s) are not significantly **(P ≤ 0.05)** different accordingly to Duncan's multiple range test.

The results obtain are in agreement with those of Sikandar *et al*., (2017). It was found from the pooled data of both years that maximum populations of fruit flies (irrespective of species) were attracted to yellow and transparent colored traps. In the year, 2016, peak population was observed in August, however in 2017, two peaks were observed in the 3rd week of August and September. The fruit flies species identified from citrus orchards were *Bactrocera zonata* and *B. dorsalis*. Because fruit flies showed more attraction to yellow and transparent colored traps, timely installation of these traps is recommended as a part of integrated pest management for monitoring, detection and control of fruit flies.

In addition, Toorani and Abbasipour (2017) reported that yellow color is one of the most influential physical stimuli used in the manufacture of adhesive and McPhail traps, whether for mass trapping or use monitoring programs, and that there is no significant relationship found between color and direction in males. To reduce environmental contamination with chemical insecticides, the use of sticky colored cards is recommended (Pezhman *et al.*, 2010). Never-the-less, various factors such as shape, color, and location can affect the efficiency of traps (Hashem *et al*., 1987).

There were significant (P ≤ 0.05) differences in the population density of the fruit fly (*B. zonata*) attracted by the different colors at south, west and center directions (Table 1). At the south direction, the number of the insects attracted by the yellow and white traps was significantly higher than to the number of the insect attracted by the red traps. The density of the insect attracted by the yellow, white and red colors was 10.00, 8.42 and 3.66 insects per trap, respectively. There were no significant differences in number of insects attracted by the white, yellow, green and blue traps.

At the west direction, the number of the insects attracted by the white and yellow traps was significantly higher than the number of the insect attracted by the blue traps (Table 1). The density of the insect attracted by the white, yellow and blue colors was 9.2, 5.67 and 4.83 insects per trap, respectively. There were no significant differences in number of insects attracted by the white, yellow, green and red traps.

At the west and center directions, the number of the insects attracted by the green traps was significantly higher than the number of the insects attracted by the red and blue traps (Table 1). The population density of the insect attracted by the green, red and blue colors was 10.00, 2.58 and 5.25 insects per trap, respectively. There were no significant differences in number of insects attracted by the white, yellow and green traps.

In general, the number of the insects attracted by the white traps was significantly higher than the number of the insects attracted by the red traps (Table 1). The population density of the insect attracted by the white and red colors was 7.27 and 4.32 insects per trap, respectively. There were no significant differences in number of insects attracted by the yellow, green and blue traps.

Despite that the number of insects attracted by the different colors was low during the period from March to October, the number of insects attracted by the yellow color was the highest compared to the number of insects attracted by the other colors (Figure 1). The population density of the insect was increased gradually from November to February, whereas the insect's number attracted by the yellow color was the lowest compared to the number attracted by the other colors, particularly the green color.

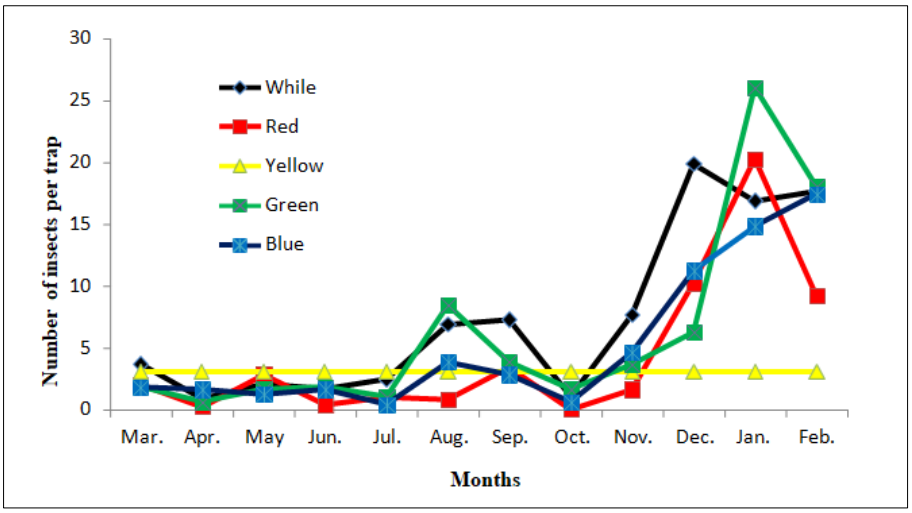

Figure 1: Effect of color on the density of the fruit fly (*Bactrocera zonata)* in the Gezira State, Sudan, during the 2016/ 2017 season

The results obtained were inconsistent with the findings of Velasco-Pascuadl and Enkerlin, (1980), who reported that the fluorescent yellow color had more fly attraction than white. Fruit flies such as *Bactrocera oleae* (Prokopy *et al.,* 1975), Queensland fruit fly, *Bactrocera tryoni* and similar species *B. neohumeralis* and *B. acuminates* (Hill and Hooper, 1984) had the most attraction to yellow or fluorescent yellow (520-540 nm peak reflectivity) and generally flies of the family Tephritidae had most tendency to yellow and fluorescent yellow (Prokopy *et al*., 1975).

Effect of Cultural and Sanitation Measures on Density of Fruit Fly (*Bactrocera Zonata*) in Different Areas in the Gezira State, Sudan, During Season 2016/2017

The results obtained showed that there were significant ($P \leq 0.05$) differences in the population density of the insect between the well managed orchards and the poorly managed orchards throughout the study period (Figure 2). The number of the insects per trap was lower in the well managed orchards than in the poorly managed orchards.

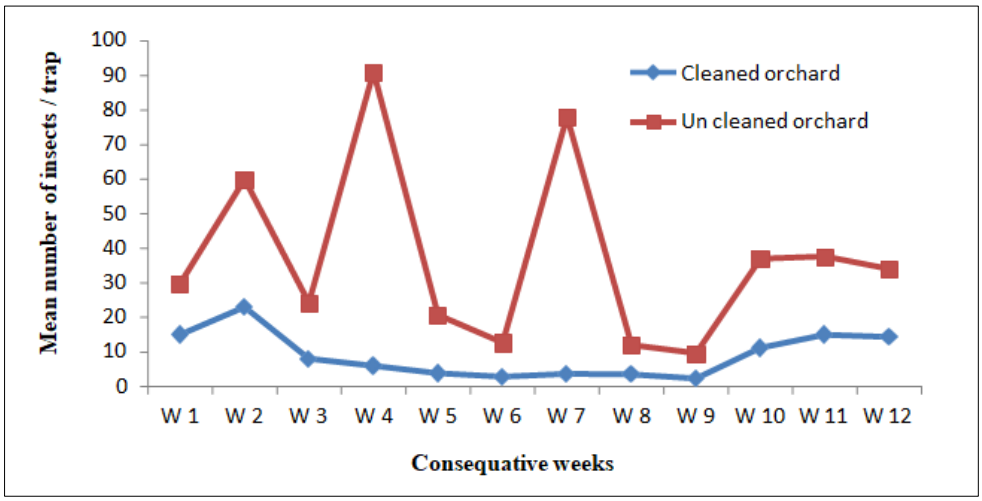

Figure 2: Effect of cultural and sanitation measures on density of fruit fly (*Bactrocera zonata*) in different areas, Gezira State. Sudan, during the 2016/ 2017 season

The low number of the insects per trap in the well managed orchards could be attributed to the well cultural practices and good sanitation measures followed. Various phytosanitary procedures are used for fruit fly suppression, containment, eradication and exclusion. These procedures may be applied to establish and maintain fruit fly-pest free areas and areas of low fruit flies prevalence. The effectiveness of field sanitation increases when the collection and disposal of fallen fruits are focused on the preferred hosts and are done continuously on an area-wide basis (*Han et al*., 2011; *Ye et al*., 2013).

For good results, collection and disposal should be done before, during and after harvest. Fruits that remains on the host plants after harvest, fruit rejected because of poor quality during harvest and packing, and fruit on host plants present in the surrounding area should

be collected and safely disposed of (e.g. by deep burial). Elimination or maintaining a low level of vegetation at the place of production will facilitate collection of fallen fruit. In addition, when vegetation is kept low, fallen fruit with larvae will be more exposed to direct sunlight and natural enemies, which will contribute to increased fruit fly larvae mortality. Bagging of fruits and use of exclusion netting can prevent fruit fly infestation of the fruit. Where used, bagging or exclusion netting should be carried out before the fruit becomes susceptible to fruit fly infestation. The pupae of many fruit flies can be targeted by disturbing the soil medium in which they pupate. This can be done by ground swamping (causing pupae anoxia) or ploughing (causing physical damage, desiccation to the pupae and exposing t to natural enemies) (FAO, 2015).

During the flowering period of mango, peach fruit fly (*Bactrocera zonata*) was highly attracted to other colors rather than the yellow color, whereas, during the fruiting the insect was highly attracted to the yellow color compared to the other colors. The population density of the insects was significantly lower in the well managed orchards (8.7 insects per trap per week) than in the poorly managed orchards (36.9 insects per trap per week). Thus, the trap color, composition of the horticultural crops, good cultural practices and sanitation measures should be considered when dealing with the control of peach fruit fly.

REFERENCES

- Elbasher, O.A. 2016. Vermination of climate changes using rainfall and temperature as indicators and its impacts on agricultural production in the arid zone of Sudan. Ph.D. Thesis, page 40-50 University of Gezira, Sudan.
- EPPO. 2005. *Bactrcera zonata*. Bulletion OEPP/ EPPO Bulletin, 43(3):412-416. doi:10.1111/ epp.12058
- FAO. 2015. Fruit Fly Control for Mango Farmer in Ghana. https://www.fao.org
- Fetoh, B.E. 2012. Temperature-Dependent Development and Degree-Days Models of the Peach Fruit fly, *Bacterocera zonata* (Saunders) and the Cucurbit Fly, *Dacus ciliates* (Loew). International journal of Environmental Science and Engineering (IJESE) Vol. 3: 85- 96
- Fletcher, B.S. 1987. The biology of Dacinae fruit flies. Annual Review of Entomology, 32: 115-144
- Han, P., X. Wang, C. Y. Niu, Y. C. Dong, J. Q. Zhu and N. Desneux. 2011. Population dynamics, phenology, and overwintering of *Bactrocera dorsalis*, (Diptera: Tephritidae) in Hubei Province, China. Journal of Pest Science, 84:289–295.
- Hashem, A.G.; E. J. Harris and M. H. Saharan. 1987. Efficiency of different types of lure traps for detecting and monitoring the Mediterranean fruit fly, *Ceratitis capitata* (Wied.) in Egypt. Zagazig Journal of Agricultural Research, 14(1): 797-814.
- Hill, A.R. and G. H. S. Hooper. 1984. Attractiveness of various colors to Australian Tephritid fruit flies in the field. *Entomologia Experimental Applicata*, 35, 119-128.
- Imran, R.N.A.; S. M. Masoom; S. Rashdi; M. Ismail and M. H. Khan. 2013. Laboratory studies on ovipositional preference of the peach fruit fly *Bactrcera zonata* (Saunders) (Diptera: Tephiritidae) for different host fruits. Afr. J. Agric. Res., 8(15): 1300-1303.
- Kapoor, V. C. 2008. Theory and practice of animal taxonomy / *Kapoor*, *V.C.*; Edition: 6th edition; Description: xiii, 258 p.; 20 cm; ISBN: 9788120417205
- Mafirakurewa, V.C. 2014. Diversity and Population Dynamics of *Bactrocera invadens* and other Tephritidae Fruit Flies Species Infesting Mango (*Mangifera indica*), in Zimbabwe and Relative Efficacies of Selected In Insecticides in Corporate in Food Baits. Thesis, University of Zimbabwe, Faculty of science, Department of Biological Sciences.
- Mahmoud, M.E.E.: M. A. Kambal: S. M. Abukashawa: S. A. Mohamed and Mahmud, M.E.E.: A. O. Kambal: nd S. M. A. Abukashwa. 2012. Prospects of Using Protein Hydrolastes for Trapping and Monitoring Major Fruit Flies (Tephritidae: Diptera) in Sudan. Persian Gulf Crop Protection Journal. 1
- Pezhman, H., H. Ostovan, K. Kamali and V. Rezaei. 2010. Evaluation of various traps and attractants for mass trapping the Mediterranean fruit fly, *Ceratitis capitata* (Diptera:Tephritidae), in a mixed-fruit orchard in Shiraz. 19th Iranian Plant Protection Congress, 31 July - 3 August 2010, Tehran, Iran, p 486.
- Prokopy, R.J.; A. P. Economopoulos and M. W. Mc-Fadden. 1975. Attraction of wild and laboratory cultured *Dacus oleae* flies to small rectangles of different hues, shades and tints. *Entomologia Experimental Applicata*, 18: 141-152.
- S. Ekesi . 2016. Seasonal abundance of major fruit flies (Tephritidae: Diptera) in Khartoum, Kassala and South Kordofan State, Sudan. Journal of Agricultural Research, 26: 79-90.
- Salah, F.E.E., H. Abdelgader and M. De Villiers. 2012. The occurrence of the peach fruit fly, *Bacterocera zonata* (Saunders) (Tephritidae) in Sudan. TEAM 2nd International Meeting: Biological Invasions of Tephritidae: Ecological and Economic Impacts (pp.3-6). Crete. Kolymbari, Greece (2): 6-14.
- Sikandar, Z., M. B. S. Afzal, M.U. Qasim, A. B. A. Aziz, M. N. Khan, K. M. Mughal, and H. Tariq. 2017. Color preferences of fruit flies to methyl eugenol traps, population trend and dominance of fruit fly species in citrus orchards of Sargodha, Pakistan. *Journal of Entomology and Zoology*

Studies, 5(6), 2190-2194.

- Toorani, A.H. and H. Abbasipour. 2017. Effect of geographical directions, height and the color of yellow traps in capture of Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann, 1824) in citrus orchards. Acta Agriculturae Slovenica, 109 (3): 561 – 575.
- Velasco-Pascual, H. & D. Enkerlin. 1980. Efectos del color en trampas para captura de la mosca mexicans in capture of Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann, 1824) in citrus orchards. Acta Agriculturae Slovenica, 109 (3): 561 – 575.
- White, I.M. and M. M. Elson-Harris.1992. Fruit flies of economic significance: their identification and bionomics. CAB International and Australian Government.
- Ye, W. F., L. Li, C. W. Xie, W. X. Ding and C. Xiao. 2013. The effectiveness of removing fallen fruit on control of the oriental fruit fly *Bactrocera dorsalis* and evaluation of the infestation rate of this pest in five mango varieties. *Chinese Journal of Applied Entomology*, 50, 1126–1132.

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