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Research Article

Mass Trapping of Live Male *Bactrocera dorsalis* Hendel (Diptera: Tephritidae): Interaction between Trap Types and Period of Trapping

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Mass trapping of insects involves the use of specific traps or devices that are designed to attract and capture a large number of adult insects, thereby reducing their population in the agricultural environment. This approach aims at disrupting the breeding cycle and proliferation of the target insect to minimize crop damage and economic losses. This study evaluated the efficiency of three trap types (Ecoman, Tephri, and Bucket funnel) and period of the day (morning, afternoon, and evening) in mass trapping of live male *Bactrocera dorsalis* and the survival of such catch over a period. The traps were deployed on selected trees following 3×3 factorial experiments. All the *Bactrocera dorsalis* caught in the traps were males. Ecoman traps caught the highest number of *B. dorsalis* in the mornings and evenings while Tephri traps caught the highest *B. dorsalis* in the afternoons. There was no significant difference in the survival of *B. dorsalis* in the three trap types after 24 hours. Correlation analysis showed that climatic factors played a significant role in trap catches. *Bactrocera dorsalis* caught in the evenings recorded higher percentage survival in all the three trap types than those caught during the morning and afternoon. The Ecoman trap was most efficient in trapping *B. dorsalis*. Hence, this study recommends the Ecoman trap for mass trapping live male *B. dorsalis* meant for further experiments such as irradiation studies.

1. Introduction

Insect trapping system is one of the most common tools for bio-systematics studies and biological control of fruit flies. The efficiency of trapping systems varies according to the trap type, type of lure and its concentration, population density of the target insect, weather conditions, and trap placement such as height from ground and orientation [1]. The mass trapping method represents a preventive control measure which is based on attracting and killing adult fruit flies before they get to the fruit to lay eggs. The key advantage of the mass trapping method is the exclusion of fruit flies and the avoidance of whole canopy contamination by insecticides. Mass trapping methods can be applied by using traps of different constructions, which must be set on tree canopies or anywhere within an orchard. The traps may contain different types of attractants and a killing agent which is usually an insecticide [2–6]. It has been suggested that mass trapping has a better efficacy than bait sprays and has a lower cost of application [3, 7–10]. Trap designs, including different colours and shapes, are essential to obtain a high efficiency in fruit fly catches [11–15]. Afro-tropical fruit fly pests in the genera *Bactrocera*, *Dacus,* and *Zeugodacus* (subtribe Dacinae) are known to respond to

either methyl eugenol (4-allyl-1, 2-dimethoxybenzene-carboxylate) or Cue-Lure (4-(p-acetoxyphenyl)-2-butanone) [16, 17].

Trapping a large proportion of the wild population of an insect pest is essential for the success of sterile insect technique (SIT) programs which require the release of sterilized field-trapped adults to control wild populations [18]. For SIT and many other control strategies such as gene drive techniques, cytoplasmic incompatibility techniques, and biological control that require the release of insects, it is essential to estimate the size of the wild population of the target insect before employing such strategies. Mark-release-recapture is the most efficient method for estimating the size of wild populations. The ability to trap live insects, release them in good condition to mix with the wild population, and be recaptured is also essential in SIT. Therefore, it is important to optimize the trapping of live insects as part of key pest management strategies. The type of trap to be used for mass trapping of live insects is important as the capacity for capturing live insects may differ among different trap types. Hence, there is a need to evaluate different traps to determine their efficiency for trapping live insects. Specific trapping systems should be used depending on the objectives of specific pest control programs. Factors including economic and technical feasibility, species of fruit fly, and the phytosanitary condition of the areas of concern could be considered before employing SIT [19].

In this study, three different traps for capturing males of *Bactrocera dorsalis* and the ideal period of the day for mass trapping live adult males meant for further studies were evaluated. The study also investigated the influence of weather conditions (temperature, humidity, and rainfall) on trap efficiency.

2. Materials and Methods

2.1. Study Location. A major mango (*Mangifera indica* L.) growing area (Manya Krobo District) in the Eastern Region of Ghana was selected for this study due to its history of being a home to many mango varieties, both local and exotic. Fruit fly sampling was performed in Power of Trinity Farm (POT) (6°6′12″N; 0°0′7″W) (Figure 1) from March 2019 to June 2019. The POT farm houses a mixture of Keitt and Kent varieties of mangoes. All mango trees in the farm had exceeded the economic fruit-bearing age of seven years at the time of data collection.

2.2. Trap Types. Trapping was performed according to International Atomic Energy Agency (IAEA) guidelines [19] with few modifications. Three different traps, that is, the Ecoman fruit fly trap (Ecoman Biotech, Beijing, China), Tephri trap (SORYGAR, Madrid, Spain), and Bucket funnel trap (Insect Science, Tzaneen, South Africa), were evaluated to ascertain their efficiency and effectiveness in collecting a large number of adult males of *Bactrocera dorsalis*. Captured *B. dorsalis* males from each trap type were tested for their survival under laboratory conditions (i.e., 25 ± 1°C; 75 ± 5% RH; 12D:12L photoperiod).

The Ecoman fruit fly trap (Figure 2(a)) is a vertical cylinder, with a height of 17 cm and an average diameter of 5.83 cm at the top entrance. The total volume of the trap is about 449 ml. It has a white translucent bottle and a black cap (0.65 cm high and 0.70 cm wide) which can be unscrewed to facilitate servicing. The black cap is dome-shaped, with four spiral entry points (each 0.13 cm in diameter). A plastic pin (0.6 cm in height) attached to the inside of the cap serves as a holder for the attractant. The trap was hung on a hook on top of the dome-shaped black cap.

The Tephri trap (Figure 2(b)) is similar to a McPhail trap. It is a vertical cylinder with a height of 10.6 cm and a diameter of 11.6 cm at the base and can hold up to 1,119 ml of liquid. It has a yellow base and a clear top, which can be separated to facilitate servicing. There is a platform inside the top to hold attractants. A nylon thread, placed on top of the trap body, was used to hang the trap on tree branches [19].

The Bucket funnel trap (Figure 2(c)) consists of a tapered upper yellow pane (the funnel), white lower collection bucket, green lid, white caps, and green pheromone basket/cage. It is also a vertical cylinder, with a height of 12.6 cm and a diameter of 12.8 cm. It can hold up to 1,621 ml of liquid. The green lid has two holes on top with a thread for hanging the trap.

The traps were hung on the mango trees using a nylon thread. Grease was applied to the first one-third proximal part of the thread near the branch to prevent ants from preying on the captured *B. dorsalis*. Traps were rotated monthly to prevent the location of a trap from interfering with its performance.

2.3. Attractant. Methyl eugenol (ME, Scentry Biologicals, Inc, Billings, MT), a known attractant of adult males of *B. dorsalis* over long distances, was placed in a slow-releasing polymeric gel form [20, 21]. No killing agent was added to the attractant in the traps because the captured flies needed to be kept alive and their survival monitored. To avoid contamination from other odour sources, only new traps were used. The applicators' hands were also covered with disposable latex gloves during trap handling and placement.

2.4. Fruit Fly Sampling and Monitoring. An area of 12,141 m^2 within the 32,375 m^2 farm was demarcated as the sampling area for fruit fly collection. The mango trees were selected systematically to cover the area uniformly. Within the sampling area, three blocks were demarcated 10 m apart. Within each block, a total of 15 trees, 9 m apart, were systematically selected and tagged. Fifteen traps (one per tree) were deployed on the selected trees at a height of 2.0 m above ground depending on the architecture of the tree [22]. The deployment of traps followed a 3×3 factorial arrangement. The 3×3 factorial arrangements multiplied by the three blocks resulted in twenty-seven experimental units for the sampling area (12,141 m^2). The 15 traps per block consisted of five Ecoman traps, five Bucket funnel traps, and five Tephri traps. Methyl eugenol polymeric gel was used as an attractant in the traps. The traps were placed in semi-shaded and upwind parts of the canopy at 6:00 am on

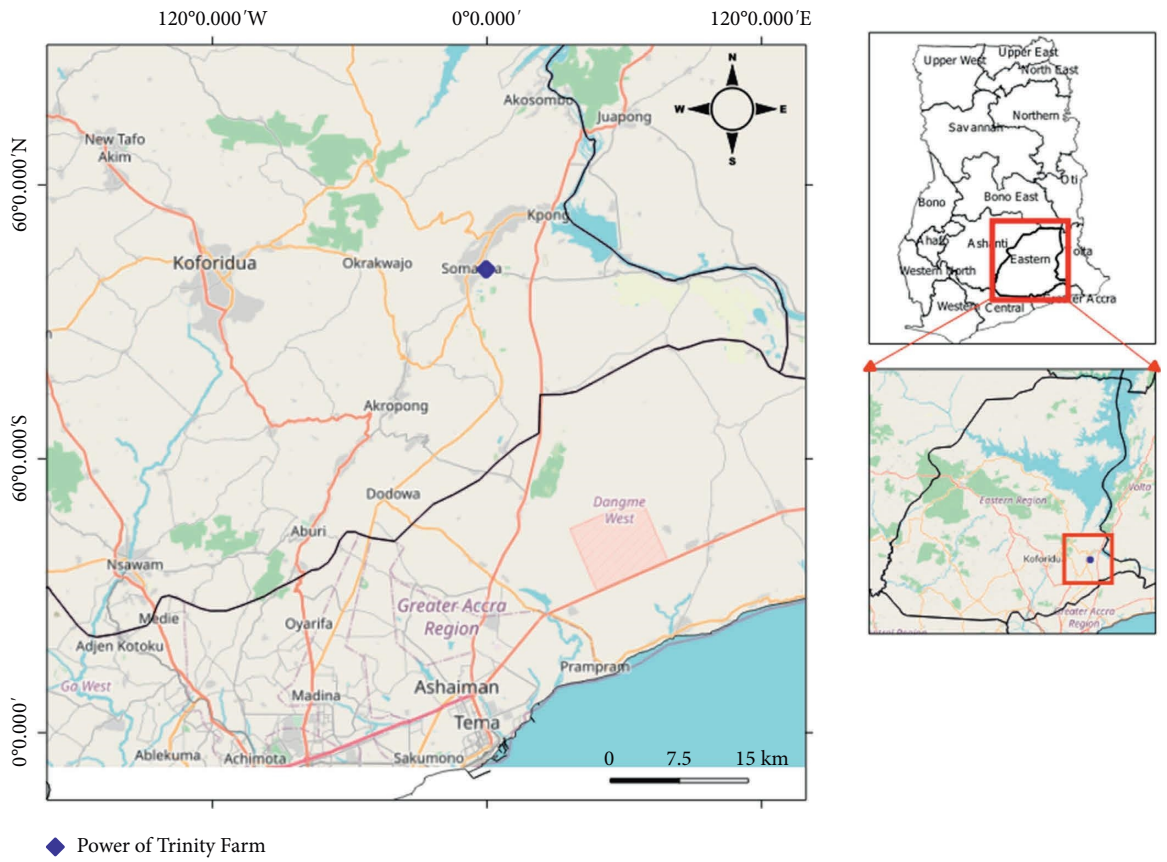

Figure 1: Location of Power of Trinity Farm (marked in blue) in the coastal savanna agroecological zone of Ghana.

(a) (b) (c)

Figure 2: Traps used for sampling males of *Bactrocera dorsalis*. (a) Ecoman trap; (b) Tephri trap, and (c) Bucket funnel trap. Photo credit: Enoch Selorm Kofi Ofori.

sampling days. The traps were left in the field for 3 hours each in the morning, afternoon, and evening. Flies caught between 6:00 am and 9:00 am were designated as morning catches. Those caught between 12:00 noon and 3:00 pm were designated as afternoon catches and those caught between 4:00 pm and 7:00 pm were designated as evening catches. The catches of each trap for each designated period were carefully emptied into a cage. The flies were provided with enzymatic yeast hydrolysate, sugar (three parts yeast: one part sugar), and distilled water soaked in cotton wool in a small vial inside the cage [22]. Another cotton wool soaked in water was placed on top of each cage to keep the catches hydrated and the cage humid. While on the field, each cage was labeled with the respective trap type and period of catch and placed under shade. At the end of the day, the catches were transported under a temperature condition of 20°C to the laboratory for further studies. The flies were monitored for 30 days under laboratory conditions for survival or

mortality. An artificial diet (three parts yeast: one part sugar) and water were provided to fruit flies that were confirmed to be male *B. dorsalis ad-lib*. Fruit fly sampling was replicated three times over the periods of March, May, and June 2019.

2.5. Taxonomy and Identification of Captured Fruit Flies. The captured fruit flies were confirmed as adult males of *Bactrocera dorsalis* based on morphological characteristics using taxonomic keys developed by the African Fruit Fly Initiative [22]. The flies were viewed under a dissecting microscope (GX Microscopes, GT Vision Ltd, Suffolk, UK) at a magnification of 20×. Nontephritid flies were identified to order or family levels but were not used in this research. Samples of the identified insects were deposited at the Radiation Entomology and Pest Management Centre under the Biotechnology and Nuclear Agriculture Research Institute of the Ghana Atomic Energy Commission.

2.6. Climatic Data. A TinyTag data logger (Gemini Data Logger Ltd, West Sussex, UK) was installed in the orchard to collect climatic data. It was launched to collect the temperature, relative humidity, and dew point readings every 60 minutes. At the end of the day, it gives the daily summary. The daily summary of the temperature and relative humidity was then converted to mean monthly summaries. The rainfall reading was collected using PS, PP Rain Gauge (Shreeji Instrument, Gujarat, India). The rain gauge gives a weekly reading which is converted into mean monthly summaries. The rainfall pattern in the study area was bimodal. Thus, two peaks of rainfall events occurred in the study area, one in the major cropping season (beginning from May to July) and the second in the minor cropping season (beginning from September to November).

2.7. Statistical Analysis. The number of *B. dorsalis* adult males captured by the traps was subjected to analysis of variance (ANOVA). The effect of trap type and period of the day on the number of *B. dorsalis* male catches and the percentage survival were subjected to Fisher's test. Data were input into Microsoft Excel to generate nine samples for the trap type and period of the day, representing the sample size (n) used in ANOVA for the single factor effect using Genstat software [23], by selecting a general treatment structure to run the 3×3 factorial experiment. Data were log-transformed to normalize the initial distribution of raw data collected for males of *B. dorsalis* catches and the percentage survival of flies in traps before performing ANOVA. Correlation and regression analyses were performed between the trap catches and climatic data measured during the study.

3. Results

3.1. Response of Adult Male Bactrocera dorsalis to Trap Types. All adult *B. dorsalis* caught were males. The trap catches showed that the Ecoman trap was the most efficient in catching large numbers of adult males of *B. dorsalis* (Figure 3). The Tephri trap also caught more male *B. dorsalis* compared to the Bucket funnel trap. The weekly catches were significantly different among the trap types ($F_{(2,15)} = 26.44$, $p \leq 0.001$) (Figure 3).

There were no significant differences in the survival of adult male *B. dorsalis* in the three trap types under study during a 24-hour study period ($F_{(2,14)} = 0.08$, $p \leq 0.924$). However, numerically more male *B. dorsalis* survived in the Ecoman trap followed by the Bucket funnel trap and Tephri trap (Figure 4).

Survival of captured *B. dorsalis* adult males in Ecoman traps was highest in the evening captures followed by the afternoon captures before the morning captures albeit not statistically different (Table 1). A similar trend was observed in the captures by the Bucket funnel trap. In the Tephri trap, the highest survival was in the evening, followed by the morning before the captures in the afternoon (Table 1). There were no significant differences in the percentage survival of *B. dorsalis* males that were captured in the three trap types at the three different periods of the day after 24 h in the insectary ($F_{(2,14)} = 0.10$, $p < 0.979$) (Table 1).

3.2. Interaction between Trap Catches and Period of the Day. There were significant differences in the interaction between the trap types and the period of the day ($F_{(4,15)} = 6.69$, $p \leq 0.003$). In the morning, Ecoman traps caught higher numbers of *B. dorsalis* adult males than Tephri and Bucket funnel traps. Again, in the morning the number of *B. dorsalis* males caught by Tephri and Bucket funnel traps was not significantly different (Table 2). In the afternoon, there were no significant differences in the mean catches by Ecoman, Tephri, and Bucket funnel traps (Table 2). In the evening, Ecoman traps were efficient in catching large numbers of male *B. dorsalis* compared with Tephri and Bucket funnel traps. However, the number of *B. dorsalis* males caught by Tephri and Bucket funnel traps was not significantly different (Table 2). Moreover, in the Ecoman traps, there were significantly more catches in the morning than in the afternoon. However, the catches in the afternoon were not significantly different from those in the evening and the catches in the morning were also not significantly different from those in the evening (Table 2). In the Tephri traps, the catches in the morning and afternoon were not significantly different but both were significantly higher than the catches in the evening (Table 2). The catches in the Bucket funnel traps were not significantly different among all three periods of the day (Table 2).

3.3. Response of Adult Males of Bactrocera dorsalis to Period of the Day. There were significant differences in the mean number of adult male *B. dorsalis* caught at the different periods of the day ($F_{(2,15)} = 9.24$, $p \leq 0.002$). The number of *B. dorsalis* males caught in the morning was significantly higher than the numbers caught in the afternoon and evening. However, the catches in the afternoon compared to those in the evening were not significantly different (Figure 5).

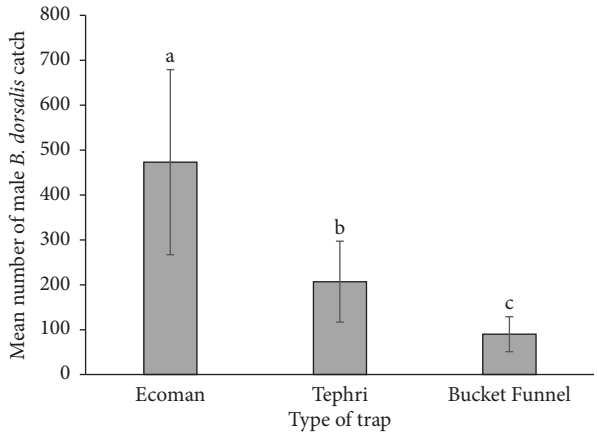

Figure 3: Mean catches of adult males of *Bactrocera dorsalis* in three different trap types.

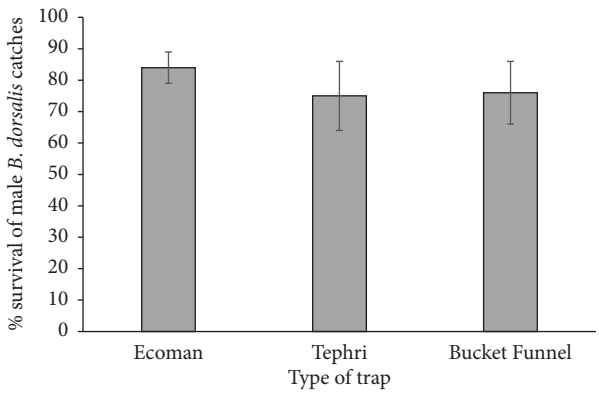

Figure 4: Percentage survival of adult males of *Bactrocera dorsalis* in Ecoman, Tephri, and Bucket funnel traps.

Table 1: Percentage survival of adult males of *Bactrocera dorsalis* in three trap types after catches in 24 hrs on a mango plantation.

Trap type	Period of day	Mean survival (%) ± SE
Ecoman	Morning	69 ± 10^a
	Afternoon	88 ± 8^a
	Evening	95 ± 2^a
Tephri	Morning	73 ± 17^a
	Afternoon	64 ± 32^a
	Evening	87 ± 10^a
Bucket funnel	Morning	49 ± 25^a
	Afternoon	88 ± 7^a
	Evening	92 ± 5^a

Means followed by the same letter within the column are not significantly different.

There were significant differences in the percentage survival of *B. dorsalis* adult males at different periods of the day within a 24-hour period ($F_{(2,14)} = 8.83$, $p \leq 0.003$). A significantly higher number of males of *B. dorsalis* survived in the evening than in the morning. Similarly, a significantly higher number of the flies survived in the traps set up in the afternoon than in the morning. However, there was no significant difference between the flies caught in the afternoon and evening (Figure 6).

3.4. Interaction between Trap Catches and Weather Parameters. The average rainfall, temperature, and relative humidity for the first trapping period in March 2019 were 45 mm, 31°C, and 72%, respectively. The average rainfall, temperature, and relative humidity for the second trapping period in May 2019 were 145 mm, 30°C, and 77%. In June, the average rainfall, temperature, and relative humidity for the third trapping period were 195 mm, 28°C, and 80%, respectively.

Correlation analyses between adult males of *B. dorsalis* trap catches and weather parameters showed no significant differences. Temperature ($r = 0.6638$; $p > 0.0668$), relative humidity ($r = 0.6192$; $p > 0.0754$), and rainfall ($r = 0.6182$; $p > 0.0760$) were positively correlated with Ecoman traps. Even though Ecoman trap catches had a positive correlation with climatic factors, there were no significant differences among them. There was a strong positive correlation observed between the weather parameters and the *B. dorsalis* adult male catches for the Tephri trap: temperature ($r = 0.7766$; $p < 0.0138$), relative humidity ($r = 0.7220$; $p < 0.0281$), and rainfall ($r = 0.7196$; $p < 0.0138$). A similar correlation was observed for the catches in the bucket funnel traps. There was a strong and significant correlation between catches in the bucket funnel traps and temperature ($r = 0.7286$; $p < 0.0404$) as well as relative humidity ($r = 0.7001$; $p < 0.0354$). On the contrary, the correlation between catches in the bucket funnel traps and rainfall was not significant ($r = 0.6705$; $p > 0.0688$).

4. Discussion

4.1. Response of Adult Male Bactrocera dorsalis to Trap Types. Adult fruit flies are normally monitored with traps containing attractants [19, 24, 25]. The choice of trap for mass trapping depends mainly on the type of attractant to be used [19]. In the present study, adult males of *B. dorsalis* were collected at three different periods during the day (i.e., morning, afternoon, and evening) in mango orchards using three different trap types with methyl eugenol as the attractant. Methyl eugenol was chosen because it is a known attractant of adult males of *B. dorsalis*, the target pest [17, 20]. Males of *B. dorsalis* collected in the evening with the baited traps had a higher survival rate for the first 24 hours after trapping than those collected in the morning and afternoon. This could be due to the more favourable weather conditions in the evening. The evenings had relatively low temperatures (28 ± 1°C) and high humidity (77 ± 5%) that might have aided the survival of the captured fruit flies in the traps.

The mean percentage survival of *B. dorsalis* male catches in the Ecoman trap was 84%, followed by Bucket funnel trap (76%) and Tephri trap (74%). Motswagole et al. [26] and Choi et al. [27] reported 16.7°C to 34.9°C as possible optimum temperatures for the survival of flies during the period

Table 2: Trap catches of adult males of *Bactrocera dorsalis* at different periods in the day.

Trap type	Period of day		
	Morning (6 am–9 am)	Afternoon (12 pm–3 pm)	Evening (4 pm–7 pm)
Ecoman	933 ± 546^{a}	126 ± 61^{bcd}	361 ± 187^{ab}
Tephri	231 ± 121^{bcd}	320 ± 239^{abc}	69 ± 45^{d}
Bucket funnel	108 ± 59^{bcd}	125 ± 111^{cd}	38 ± 18^{d}

Means followed by different letters within columns are significantly different at $p < 0.003$ (Fisher's test).

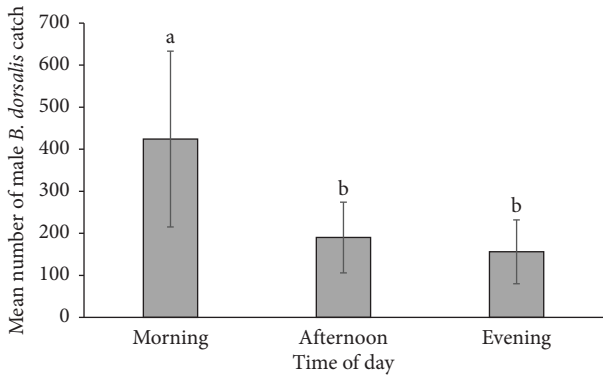

Figure 5: Mean catches of adult males of *Bactrocera dorsalis* at different periods of the day.

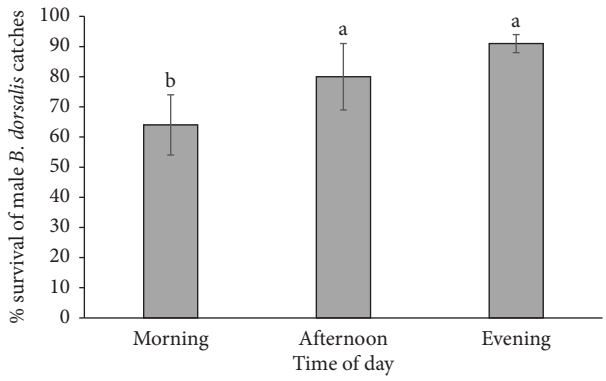

Figure 6: Percentage survival of adult males of *Bactrocera dorsalis* in three different periods of the day.

of capture. The success of the mass trapping strategy depends on the efficiency of traps and lures for collecting live insects [28]. The traps used in the experiments posed little or no harm to the environment because no killing agent was added to the traps [29–32]. Methyl eugenol is highly attractive but very specific in attracting fruit flies in the *Bactrocera* complex including *B. dorsalis*. In fact, earlier studies have shown that methyl eugenol is very effective in mass trapping *Bactrocera* species in mango orchards [33, 34]. Our findings suggest that the best trap to capture live adult male *B. dorsalis* for further studies is the Ecoman trap.

4.2. Response of Captured Male Bactrocera dorsalis to Period of the Day. In all the three types of traps, more than 80% of *B. dorsalis* survived in the traps set in the evening. This implies that, it is advisable to set the Ecoman trap in the evening for mass trapping of live adult males of *B. dorsalis* since it had the highest percentage survival of the flies. Our finding is in line with those of Siddiqui et al. [34] who stated that fruit flies exhibit a wide range of diurnal activities. Measures to control this pest should be adopted during the morning and evening hours. This is premised on the fact that the fruit flies were found to be most active at 10:00 am–11:00 am and that adult flies spent much of the day resting on other plants in the vicinity of host crops [35]. Large populations of adults were found on host plants before 8:00 am and after 5:00 pm. The observations in this study are in close agreement with those reported in earlier studies which suggested that *B. cucurbitae* (Coquillett) and *B. dorsalis* are active in the morning [36]. In the current study, *B. dorsalis* showed an activity peak between 7:00 am and 8:00 am. Moreover, Rizk et al. [1] reported high mean catches of peach fruit flies, *Bactrocera zonata* (Saunders) between 5 am and 7 am, which is usually their mating period.

4.3. Interaction between Trap Type and Period of the Day. This study has demonstrated that the number of male *B. dorsalis* captured is influenced by trap type and period of capture. The Ecoman trap captured and retained a large number of adult male *B. dorsalis* in the mornings and evenings. The construction of the Ecoman fruit fly trap is such that the entry holes into the traps are spiraled, preventing trapped flies from escaping. The Tephri trap used in this study was a modified McPhail trap. The entrance holes were around the top of the yellow base, and an invaginated opening was in the bottom. This design probably allowed captured flies to escape since no killing agent was incorporated. Clearly, findings from this study have demonstrated that Tephri traps are not suitable for capturing live flies intended for further studies e.g., irradiation studies. The Bucket funnel trap had a wide space between the upper yellow pane and the white bucket. This window allowed captured flies to escape easily. Therefore, the Bucket funnel trap is also not suitable for retaining captured flies if no killing agent is incorporated. Findings from this study support earlier studies that suggest that trap designs, including different colours and shapes, are essential to obtain a high efficiency in fruit fly catches [11, 12, 14, 15]. Similarly, several studies have reported that tephritid fruit fly traps vary in effectiveness depending on their size, colour, shape, and the particular olfactory attractant used [12–14, 31–33, 37–39]. The type of trap is important in mass trapping. This study and others have demonstrated that the Ecoman trap is good for collecting large numbers of

B. dorsalis males due to its trapping efficiency [40]. If this trap is used in the right period of the day as demonstrated in this study, it will be very efficient in mass trapping live adult males of *B. dorsalis* for studies or programs that require live flies.

Studies have also demonstrated that adult fruit flies can be attracted to specific chemical lures during the daytime [41]. Although Ecoman traps can retain captured fruit flies very well, the flies should be released in cages within a relatively short period after capturing due to inadequate ventilation in the trap. Findings from this study show that traps set in the afternoons have low catches. This could be because of the high temperature during that period of the day and that male *B. dorsalis* find suitable refuges away from the heat of the sun.

4.4. Interaction between Trap Catches and Weather Parameters. Abiotic factors influence the capture of fruit flies by baited traps. In this study, there were positive correlations between the three trap types and climatic factors such as temperature, relative humidity, and rainfall. This implies that an increase in temperature, relative humidity, and rainfall increases the number of fruit flies that are captured in traps and vice versa.

Ecoman trap catches had a positive correlation with climatic factors although there were no significant differences among them. The Ecoman trap did not allow any captured fly to escape. The other trap types allow flies the possibility to escape. Similar findings were reported in a study in which the number of fruit flies captured with Cue-Lure-baited traps correlated positively with all three abiotic factors, i.e., temperature, humidity, and rainfall [42]. Variations in weather conditions play a vital role in the multiplication, growth, development, and distribution of insects. These also influence their population dynamics [43].

Tephri traps on the other hand exhibited a strong positive correlation with all the climatic factors recorded. This supports the findings of Khan et al. [44] who stated that weather parameters have a significant effect on the population dynamics of fruit flies. Temperature and rainfall were reported to be the most important factors influencing the population dynamics of fruit flies [45].

For the Bucket funnel traps, both temperature and relative humidity had a significant positive correlation except rainfall, which had a positive but nonsignificant correlation. Bana et al. [45] and Patel et al. [46] demonstrated a positive correlation between temperature, relative humidity, and rainfall on fruit fly catch. Even though earlier findings have demonstrated a similar relationship between fruit fly infestation and weather factors, Adzim et al. [47] reported that in the coastal grassland area, there was a negative correlation between *B. dorsalis* for both rainfall and temperature.

5. Conclusion

The three trap types evaluated had different shapes, colours, and designs, which made them unique in collecting large numbers of *B. dorsalis* adult males. Survival was higher for males of *B. dorsalis* trapped in the evening in all the three trap types. However, the Ecoman trap proved to have a higher trapping efficiency than the Tephri trap and Bucket funnel traps. Ecoman traps are therefore ideal if one is interested in mass trapping live adult males of *B. dorsalis* or for programs that require live flies e.g., irradiation studies. Climatic factors influence the catches by the traps differently. Therefore, when installing traps intended for mass trapping of live fruit flies, the optimum temperature, relative humidity, and rainfall should be considered to boost the efficiency of the traps. On the average, the survival rate of adult males of *B. dorsalis* in the traps is highest for Ecoman, followed by Bucket funnel and Tephri trap. This study provides useful knowledge for the development of trapping systems that require live flies.

Data Availability

The data used to support the findings of the study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Michael Yao Osae and Enoch Selorm Kofi Ofori conceptualised the research. Enoch Selorm Kofi Ofori and Linus Dottey collected the data. Enoch Selorm Kofi Ofori and John Abraham analyzed the data. Enoch Selorm Kofi Ofori wrote the first draft. Peter Kofi Kwapong, Michael Yao Osae, and John Abraham reviewed the first draft of the manuscript. All the authors reviewed and approved the final manuscript before submission for publication.

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