Development of a trap for collecting *Cochliomyia hominivorax* (diptera: caliphoridae) flies

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Abstract

The insect *Cochliomyia hominivorax* (Diptera: Caliphoridae) causes primary cutaneous myiasis, and the use of traps is an alternative to monitor this fly in the field. Thus, the objective of this work was to develop a low-cost trap for collecting *C. hominivorax* in the field. Three experiments were conducted, with six replications, in the experimental field of the Brazilian Agricultural Research Corporation (Embrapa - Agropecuária Oeste), in Ponta Porã, State of Mato Grosso do Sul, Brazil. Traps were developed using two-liter polyethylene terephthalate (PET) bottles cut in half, with 30 grams of bovine liver and water covering 90 % of the liver mass placed in the bottom half, using the upper half as a cover funnel to keep the captured flies in the bottom half. The experiments consisted of evaluations of different opening diameter of the trap entrance (3, 4, 6 and 7 mm) with traps installed at 1.16 m from the ground (Experiment 1), heights of installation of the traps (0.00, 0.40, 0.80, 1.20, 1.60 and 2.00 m from the ground) (Experiment 2) and bottle colors (yellow, blue, white, green, red and transparent) (Experiment 3). The collected data were subjected to Tukey's test ($p < 0.05$). The ideal traps for collecting *C. hominivorax* in the field were those with opening diameter of 6 mm, height installation of 1.20 m from the ground, using transparent PET bottles.

Keywords: Cutaneous myiasis. Sheep. Monitoring.

Introduction

Cochliomyia hominivorax (COQUEREL, 1858) (Diptera: Calliphoridae) depends on a host to complete its life cycle. This insect is an obligate parasite of endothermic animals and causes primary cutaneous myiasis in pre-existing wounds (CORONEL, 2011).

An integrated pest management program was initiated in 1957, aiming to eradicate this parasite and a process of sterilization of males of *C. hominivorax* was introduced in Florida, The United States of America, using gamma rays, decreasing its proliferation until eradication. The success of this program encouraged its use in other southeastern and southwestern states of the USA, and the *C. hominivorax* fly was eradicated from that country in 1982, from Mexico in 2001 and, finally, from Central America in 2004 (MASTRANGELO, 2011). However, in South America (except Chile) and in the Caribbean region (Cuba, Dominican Republic, Haiti, Jamaica, Trinidad and Tobago), that eradication method was not implemented (TEIXEIRA, 2013), and the incidence and damages caused by these flies are increasing, thus increasing production costs and negatively affecting the economy of these countries (OLIVEIRA; BRITTO, 2005).

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C. hominivorax insects deposit their eggs, in general, close to wounds of the host animal. The larvae hatch from the eggs and the insects (first larval stage) penetrate in live tissues of animals and feeds on fluids of their muscle tissues, which are destroyed by their buccal hooks and proteolytic enzymes contained in their saliva. Six days after larvae hatching from the eggs, they become pupae, burrying themselves into the soil for 10 days, when they become adults, beginning a new cycle (egg-pupae-adult) (LEITE, 2004).

The damage caused by *C. hominivorax* is due to a deep excavation of the animal tissues and, in more advanced infestations, they cause a serous bloody secretion of putrid smell. Depending on the attack location on the animals, these lesions become deep, impairing mammary glands, reproductive and locomotor system of the animals, leading to their death by hemorrhage (DUARTE et al., 2012).

Animals with myiasis show restlessness, increased heart frequency and decreased feed intake, which decrease meat production. Wounds are attractive to dipterous insects for egg deposition, which increase the number of larvae (hundreds or thousands of larvae in a single wound), leaving the animal even more debilitated, increasing damages and weight loss due to higher incidence of these symptoms (GOMES et al., 1998).

The use of traps to monitor pests is the most effective way to collect data on these insects in the field, their natural enemies and bio-indicators of environmental quality (MELO et al., 2001).

In this context, based on the presumption that no traps for capture flies in sheep rearing are found, the objective of this work was to develop a low-cost trap from recyclable material, for collecting *C. hominivorax* in the field, aiming to facilitate the monitoring of this pest and assist in decreasing unnecessary use of chemical control.

Material and methods

The experiments were carried out in the experimental field of the Brazilian Agricultural Research Corporation (Embrapa - Agropecuária Oeste) in Ponta Porã, State of Mato Grosso do Sul, Brazil (22°33'28"S, 55°38'37"O and altitude of 660 m). The traps were fixed on eucalyptus trees, which were planted in an area intended for rearing 50 Suffolk sheep. Three experiments with six replications were conducted from March 15 to May 08, 2014, due a greater presence of insects and sheep in the area.

The experiments consisted of evaluations of different opening diameter of the trap entrance (3, 4, 6 and 7 mm) with traps installed at 1.16 m from the ground (Experiment 1), heights of installation of the traps (0.00, 0.40, 0.80, 1.20, 1.60 and 2.00 m from the ground), to determine the ideal height for capture the flies (Experiment 2) and bottle colors (yellow, blue, white, green, red and transparent), to determine the color that most attract *Musca domestica* and *Cochliomyia hominivorax* flies (Experiment 3).

Experiment 1 - Traps were developed using two-liter polyethylene terephthalate (PET) bottles cut in half, with 30 grams of bovine liver (GOMES et al., 1998) and water covering 90 % of the liver mass placed in the bottom half. The upper half was used as a cover funnel for the attracted flies to enter the trap through holes drilled in the bottle caps with different opening diameters (3, 4, 6, 7 mm) and keep them in the bottom half by hindering their exit. The traps were placed in containers with diameter of 30 cm and height of 20 cm, which was fixed in eucalyptus trees, at height of 1.16 meters from the ground.

These traps were installed in March 15, 2014 in a completely randomized design, with four treatments (Table 1) and six replications, totaling 24 traps. Three evaluations were carried out, in the second, sixth and ninth day after the trap installations.

Experiment 2 - The experiment was conducted to measure the ideal height to install the traps. The traps were placed at heights of 0.00, 0.40, 0.80, 1.20, 1.60 and 2.00 m from the ground. These traps had opening diameter of 6 mm, which was defined as ideal in the previous experiment (Experiment 1). These traps were installed in March 26, 2014 in a completely randomized design, with six treatments (Table 1) and six replications, totaling 36 traps. Three evaluations were carried out, in the third, fifth and seventh day after the trap installations.

Experiment 3 – The experiment started while the traps of experiment 2 were still in the field. Bottles were painted with primer for color base and shade dried for two days and then, painted yellow, blue, white, green and red with fabric paints, except those that were kept for the treatment with transparent bottles.

The traps were installed in May 2, 2014 at 1.20 meters from the ground, which was defined as ideal in the previous experiment (Experiment 2), with opening diameter of 6 mm, colors randomly distributed in the field, six treatments (Table 1) and six replications, totaling 36 traps. Three evaluations were carried out in the first, fourth and sixth day after the installation of the traps.

The data collected were subjected to analysis of variance and, when significant to the F test, they were subjected to the Tukey test at 5 % probability.

Table 1. Treatments of the experiment 1, 2 and 3. Ponta Porã, State of Mato Grosso do Sul, Brazil, 2014.

Experiment 1		Experiment 2		Experiment 3	
Treatment	Diameter	Treatment	Height	Treatment	Color
1	3 mm	1	0.00 m	1	Yellow
2	4 mm	2	0.40 m	2	Blue
3	6 mm	3	0.80 m	3	White
4	7 mm	4	1.20 m	4	Green
		5	1.60 m	5	Red
		6	2.00 m	6	Transparent

Source: Elaborated by the authors (2017)

Results and discussion

In the experiment 1, traps with entrance opening of 4-mm diameter (treatment 2), captured the largest number of *Musca domestica* flies, with significant differences from the other treatments in all evaluations. Traps of 3 mm diameter (treatment 1) captured less flies due to the larger size of the insect in relation to the openings. The flies have more easily entered traps with diameter openings of 6 (treatments 3) and 7 mm (treatment 4) due to the larger opening diameter of the traps in relation to their sizes; however, this result cannot confirm that this opening size is ideal, since the easiness of entering the trap was the same as exiting, by the insects.

Traps with opening diameters of 6 mm (treatment 3) captured the highest number *C. hominivorax*, with significant differences from the other treatments. Traps with opening diameters of 3 and 4 mm (treatment 1 and 2, respectively) captured the lowest number of this fly, due to the smaller opening diameter of this trap in relation to the size of most *C. hominivorax*. The flies have more easily entered traps with opening diameter of 7 mm (treatment 4); however, they also had greater easiness of exiting these traps, therefore, this treatment was not effective to capture these flies (Table 2). Traps with opening diameter of 6 mm was more effective to monitor *C. hominivorax*, since they attracted and retained the insects inside them, thus, they can assist in decision-making for control techniques

to decrease this pest population in the field (MELO et al, 2001). Traps to capture *Anthonomus grandis* (LIMA JR, et al., 2012) and *Pecthinophora gossypiela* use insecticides to kill the insects, and some DELTA commercial traps to capture *Spodoptera frugiperda* and *Helicoverpa armigera* (MELO, et al., 2011) use bases with adhesive resins to retain the insects in the traps, requiring more investments by the producer.

Table 2. Number of *Musca domestica* (D) and *C. hominivorax* (C) captured by traps depending on the opening diameter of the trap entrance. Ponta Porã, State of Mato Grosso do Sul, Brazil, 2014.

		Experiment 1		Experiment 2		Experiment 3	
Treatment	**Diameter**	**D**	**C**	**D**	**C**	**D**	**C**
1	3	10 c	0.0 b	15.5 b	0.0 b	9.5 b	0.0 b
2	4	89 a	3.5 b	55 a	0.0 b	30 a	0.0 b
3	6	41 b	110 a	40 ab	150 a	15.6 ab	134.1 a
4	7	10 c	74.1 a	40 ab	116 a	15 b	153.3 a
Treatment	3						
Residue	20						
F	33.5		17.2	3.28	55	5.4	11.05

Means followed by the same letters in the column do not differ by Tukey test at 5 % probability.
Source: Elaborated by the authors (2017)

In the experiment 2, traps placed at height of 1.20 m from the ground (treatment 4) was ideal for capturing *M. domestica* and *C. hominivorax*, since this treatment captured the highest number of insects in all evaluations. Treatments 1 (0.0 m), 2 (0.40 m), 3 (0.80 m), 5 (1.60 m) and 6 (2.00 m) had low captures due to the flight height of these insects. The fly trap height had also been reported as a factor that affects the number of captured insects in persimmon trees (BAVARESCO et al., 2005) and cabbages (MICHEREFF et al. (2000). Moreover, Teixeira et al. (2008) evaluated the capture of *M. domestica* with traps installed at 1.00 m of height from the ground, due to the flight height of these flies. However, other studies assessing the best height for insect traps found no effect of this factor (MELO, 2011; YOUM, 1995). The authors of these studies, regardless of the effect of trap height, presented several hypotheses for these results, such as insect flight height, physical barriers by leaves and stems, and the effect of height in the attraction method.

In the present work, traps were arranged in an open location and fixed on eucalyptus trees, and the *M. domestica* and *C. hominivorax* had contact with sheep, which had adult mean height of 63 cm (ROCHA, et al. 2010), denoting that the ideal height found (1.20 m) was not affected by the height of the animals. The flight height of the flies (approximately 1.0 m) and the trap height of approximately 1.0 m probably affected the capture of these insects due to the easier access for the insects.

Table 3. Number of *Musca domestica* (D) and *C. hominivorax* (C) captured by traps depending on the trap height from the ground. Ponta Porã, State of Mato Grosso do Sul, Brazil, 2014.

		Experiment 1		Experiment 2		Experiment 3	
Treatment	**Height**	**D**	**C**	**D**	**C**	**D**	**C**
1	0.0	3.0 b	3.0 b	19.5 ab	8.75 b	8.25 ab	7.0 b
2	0.40	2.0 b	5.25 b	6.0 ab	33.25 b	33.25 ab	15.75 b
3	0.80	0.25 b	6.25 b	1.75 b	29.75 b	11.25 ab	5.0 b
4	1.20	9.25 a	162.5 a	30.5 a	106.5 a	18.25 ab	5.25 b
5	1.60	1.25 b	19.2 b	2.5 ab	29.75 b	4.0 b	15.75 b
6	2.00	1.50 b	67.5 ab	4 ab	60.75 ab	37.25 a	61.00 a
Treatment	3						
Residue	20						
F	33.5	1.9	8.3	3.45	8.14	4.12	13.76

Means followed by the same letters in the column do not differ by Tukey test at 5 % probability.
Source: Elaborated by the authors (2017)

In the experiment 3, traps made with transparent polyethylene terephthalate (PET) bottles (treatment 6) had the best performance in capturing *M. domestica* and *C. hominivorax*. The trap color affected the behavior of the insects. The use of colors to attract insects has been reported in the literature, in several types of traps. For example, *Liriomyza trifolli* and *Diabrotica speciose* are attracted by yellow (GAERTNER; BORBA, 2014); red attract large number of insects of several species of the Amazon forest (PENA; HENRIQUES, 2004), and green is efficient in monitoring insect pests in *Plinia cauliflora* (AZEREDO, 2007). However, according to an evaluation of trap color to capture fruit flies, the trap color does not affect the capture of these insects in some situations (ADAMUCHIO, et al., 2008). In the present work, traps with yellow, blue, white, green and red color did not affect the attraction of the insects, capturing a lower number of flies compared to the transparent traps.

Traps made with PET bottles are widely used to capture insects, such as fruit flies (AGUIAR--MENEZES, et al., 2006; SCOZ, et al., 2006), scolytinae (MURARI,et al., 2012) and curculionidae (MOLIN, BARRETO, 2012); however, these works aimed to monitor or control insect pests in plants, not in animals. PET bottle traps have the same effectiveness as commercial traps, lower cost and are more accessible to producers. Thus, they are a low-cost alternative to monitor and decrease insect populations, reducing the dependence on commercial products of rural properties. The present work showed that traps with opening diameter of the trap entrance of 6.0 mm, transparent color, placed at 1.20 m from the ground, in areas of sheep rearing, can be used to monitor and decrease population of *C. hominivorax*, which causes primary cutaneous myiasis in sheep.

Table 4. Number of *Musca domestica* (D) and *C. hominivorax* (C) captured by traps depending on the trap color. Ponta Porã, State of Mato Grosso do Sul, Brazil, 2014.

Treatment	Color	Experiment 1		Experiment 2		Experiment 3	
		D	C	D	C	D	C
1	Yellow	0.0 c	1.0	0.75 b	2.25 b	4.25	5.25 bc
2	Blue	1.5 c	0.0	0.25 b	3.75 b	2	6.5 ab
3	White	4.0 c	2.5	0.25 b	4.75 b	1.5	1.0 c
4	Green	13.75 a	3.0	0.0 b	2.5 b	6	16.75 ab
5	Red	5.5 c	1.2	0.75 b	2.25 b	2.25	0.75 c
6	Transparent	5.25 c	3.0	11.0 a	62.75 a	4.25	21.5 a
Treatment	3						
Residue	20						
F	33.5	77.1	8.3	1.61	45.1	1.01	6.1

Means followed by the same letters in the column do not differ by the Tukey's test at 5% probability.
Source: Elaborated by the authors (2017)

Conclusions

Traps made of polyethylene terephthalate (PET) bottles are efficient to capture *C. hominivorax* flies.

Traps with entrance opening of 6 mm diameter, transparent color, fixed at height of 1.20 m from the ground capture more *C. hominivorax* flies.

It is possible to build low-cost traps with easily available materials that are 100% recyclable.

Elaboração de armadilha para coleta de moscas que causam a miíase cutânea (*Cochliomyia hominivorax*) (diptera: caliphoridae)

Resumo

A *Cochliomyia hominivorax* causa a miíase cutânea primária. Para monitoramento de insetos em nível de campo, uma alternativa é a utilização de armadilhas. O objetivo deste estudo foi elaborar uma armadilha de baixo custo para coleta do inseto no campo. O experimento foi realizado no campo experimental da Embrapa Agropecuária Oeste, *Campus* Ponta Porã. As garrafas do tipo PET, de dois litros, foram previamente cortadas ao meio. Na parte inferior foram alocados 30 gramas de fígado bovino que foi embebido com 90 % de sua massa em água, a parte superior, previamente cortada, foi utilizada como tampa e funcionou como funil em que a mosca permanece capturada na parte inferior. Os tratamentos foram o diâmetro de abertura da tampa, altura ideal da armadilha e cor da garrafa, com seis repetições para cada tratamento. Os diâmetros de abertura foram 3, 4, 6 e 7 mm, as alturas foram 0; 0,40; 0,80; 1,20; 1,60 e 2,00 metros do solo, as cores utilizadas foram azul, amarelo, branca, verde, vermelho e transparente. Essa armadilha foi colocada em um recipiente de 30 cm de diâmetro, alocado em eucaliptos que estavam pré-dispostos no campo, com altura de 1,16 metros de altura do solo. Os dados coletados foram submetidos ao teste Tukey a 5 % de

probabilidade. A armadilha ideal para a captura da *Cochliomyia hominivorax*, que foi desenvolvida a partir dos resultados, deve ter o diâmetro de abertura de 6 mm estabelecido à altura de 1,20 m e com a cor transparente de garrafa PET.

Palavras-chave: *Cochliomyia hominivorax.* Miiase, Ovinos.

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