Efficacy of flumethrin pour on against *Haematobia exigua* infesting cattle under field conditions

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Abstract

The efficacy of flumethrin 1% pour-on (1% w/v, Flumitas) was evaluated against *Haematobia exigua* on cattle farms in Namakkal district, Tamil Nadu from November 2019 to February 2020. In this study, five farms, which had fly menace, selected randomly were divided as treatment (F₁, F₂, F₃ and F₄) and control (F_c) groups. Flies collected from the farms were identified as *Haematobia exigua* and a mean pre-treatment intensity was 195.56 ± 14.07 . In the treatment groups (F₁, F₂, F₃ and F₄) flumethrin 1% pour on was applied to the back of cattle at the rate of 1 ml/10 kg body weight and fly intensity was recorded for a period of 2 months. The fly intensity reduced to zero within 30 minutes of application and the same trend continued till 28 DPT in F₂ and F₃, while it was effective 35 DPT in F₁ and F₄. A highly significant difference in the mean *H. exigua* fly counts between control and treatment group ($P < 0.0001$) was observed.

Introduction

Haematobia flies are the most widespread and economically important pests of cattle and buffaloes. There are two species in this genus namely *Haematobia irritans* (horn fly) and *Haematobia exigua* (buffalo fly), of which *H. exigua* is a species prevalent in Asia. Both the sexes of *Haematobia*, are haematophagous. The flies spend most of their time on the animal's body and feed 24–38 times a day (Cupp et al. 1988; Oyarzun et al. 2008). Their incessant bites cause annoyance, irritation, blood loss, wound sore and disturbed feeding. Hence, during high fly intensity cattle exhibit the fly avoidance behaviour such as head toss, tail flicks, leg stamps and skin twitches to get rid of fly menace, which results in loss of energy, reduction in body weight gain and milk yield (Morgan and Baillie 1980; Gerhardt and Shrode 1980; Boland et al. 2008).

It has been estimated that a cow infested with 200 numbers of *H. exigua* adult flies will have 520 ml and 28 g reduction in milk production and live weight gain per day respectively i.e. 2.6 ml of milk and 0.14 g of live weight per fly per day per animal in Australia (Jonsson and Mayer 1999). Besides causing direct injuries, it acts as a vector for *Staphylococcus aureus* which causes mastitis (Owens 1998) and serves as an intermediate host of *Stephanofilaria stilesi* (Johnson et al. 1986), in addition to being involved in the transmission of trypanosomosis (Soulsby 2012; Sinshaw et al. 2006) and anaplasmosis (Rodriguez et al. 2009) among animals. As *Haematobia* fly menace has become major impediment for dairy production in Tamil Nadu in the recent years, control of this economically important pest is imperative. Hence, a synthetic pyrethroid with proven insecticidal efficacy and farmer friendly application mode, flumethrin pour-on product was evaluated against *H. exigua*.

Materials And Methods

Study area

The field trials were carried out on cattle farms, located in Namakkal district, which falls under North Western agro-climatic zone of Tamil Nadu (Fig. 1). The topography of the district is 11.2189° North latitude and 78.1674° East longitude with a mean sea level of 218 m. The temperature range recorded for different seasons are 23-38°C, 22-35°C and 17 - 35°C in summer, monsoon and winter respectively, with an average rainfall of 800mm.

Effect of fly menace

A total of 5 numbers of *Haematobia* fly infested cattle farms, located 1 km radius apart, with a stock rate of 10 lactating cows were selected. During the study period each animal was observed carefully to record the effect of fly menace. In all the selected farms, the animals were found to be restless with interrupted feeding. They did show fly avoidance activities such as head toss, tail twitching and leg stamps in their attempts to get rid of flies. In addition, most of the animals had skin sores associated with the bites particularly on the neck and near median canthus of the eyes (Fig. 2 and 3).

Collection and identification of flies

Approximately 45-50 numbers of flies were collected from each selected farm using aerial entomological net, carefully transferred to a glass vial containing 70 % ethanol and brought to the laboratory for identification of species. The mouthparts, wings, legs were examined under dissection and binocular microscope (Nikon, E100) and the species was identified according to the morphological keys (Kano et al. 1972; Iwasa and Ishiguro 2010).

Experimental design

Among the five farms selected for this study, four farms were treatment group ($F_1, F_2, F_3 \& F_4$), while one farm was maintained as untreated control (F_c).

Monitoring of fly intensity

In this study, filming method was used to determine pre and post treatment intensity of flies (Lima *et al.* 2002). The common areas of fly clusters such as head, neck, shoulder, abdomen and flank region were snap shot using digital camera (Canon, 14.0 Mega pixel). The images were transferred to system and were laid out on a grid pattern so as to make the counting of flies easier without error (Fig. 4). The number of flies in each animal image was counted and average was arrived.

Insecticides and Application method

Flumethrin pour-on (Flumitas, 1% w/v, Intas Pharmaceuticals Ltd, Ahmedabad) was used in this study. The insecticide was evenly applied along the midline from the front of the shoulder to the tail setting of all the animals that belonged to treatment group ($F_1, F_2, F_3 \& F_4$) at the recommended dose of 10 ml/100 kg body weight, while the animals of control group (F_c) were kept untreated.

Effect of insecticide on fly intensity

The fly population was recorded in all the animals of treatment and control groups at weekly interval for a period of 8 weeks post treatment. Data obtained in this study was subjected to one way analysis of variance using Graphpad prism version 5.

Results And Discussion

Identification of the flies

A total of 239 fly specimens which include male and female were examined under microscope (4x) to determine the species. The maxillary palps were as long as the proboscis (Fig. 5) wings with open apical cell and arista was dorsally plumed. In addition, the male had 6 long hairs with curled tip on the second segment of the hind tarsus (Fig. 6), which were absent in the female (Fig. 7). Kano et al. (1972) reported that the presence of long hairs on the second segment of the hind tarsi of male is a differentiating character between *H. exigua* and *H. irritans*. Parashar et al. (2001) and Low et al. (2017) have also reported that *H. exigua* is prevalent in India and Southeast Asia. Out of 239 flies examined, 101 and 138 flies were male and female respectively.

Results and Discussion

Effect of flumethrin pour on fly intensity

The effect of the flumethrin was complete disappearance of the flies from the cattle immediately on application of the drug. The number of flies was zero within 30 minute and the rapid disappearance has been attributed to the strong repellent effect of flumethrin in addition to its knockdown effect (Bordoloi et al. 2019). Similar repellent effect with other synthetic pyrethroid compounds have also been recorded against ticks (Mehlhorn et al. 2012), horn flies and midges (Franc et al. 1994; Schmahl et al. 2008).

A highly significant difference ($P < 0.0001$) in the fly intensity was observed between treated and control groups. Interestingly, a zero intensity of flies within 30 minutes of application of the drug and the continuation of the same trend for 28 DPT in F_2 and F_3 and 35 DPT in F_1 and F_4 (Table 1 and Fig. 8) was observed. In contrast, no such reduction in mean fly population was recorded in control group, instead the mean fly population varied between 112.9 ± 9.676 and 138.1 ± 22.56 throughout trial period.

Although flies begin to appear from 5 week post treatment in F_2 and F_3 , the intensity was found to be below the nuisance level (but no significant difference). This result indicates that the residual effect may have persisted up to 4-5 weeks. Yavuz et al. (2017) demonstrated that residual efficacy of flumethrin pour on against ticks for 28 days since the flumethrin concentrations in the blood level were higher on 28th day than on 2nd day after application. Similarly, Bissacot and Vassilieff (1997) reported that the mean flumethrin concentration in the blood was found to be higher on day 28th day ($0.29 \mu\text{g/mL}$) than on day one ($0.01 \mu\text{g/mL}$) after application in lactating cows. This prolonged activity could be due to flumethrin being absorbed very slowly after pour-on treatment and pharmacokinetic studies showed that 71.7% of

dermally applied flumethrin remained at the application site on cows after 48 hours treatment (EMEA, 1998).

The insecticidal effects of pour-on formulations of several synthetic pyrethroids were higher than other application and formulation types e.g. sprays and ear-tags (Wardhaugh 2005).

These findings provide an insight into the effectiveness of the flumethrin for 4-5 weeks period in our study. The residual presence of flumethrin in dung was not assessed during the study. An assessment of the residue in dung would enable better understanding of the fact that dung of treated animals did not attract oviposition by *Haematobia* flies.

Post treatment observations of the animals revealed improvement in the general health status of animal. The wound near the median canthus of the eye and neck which were aggravated by the persistent biting by the haematophagus flies resolved and the sore in the median canthus of the eye as well as the neck of the animals resolved spontaneously one week post the treatment. The spontaneous resolution of the wound without any specific treatment being given could be due to the complete absence of the flies which generally aggravated the wounds (Fig. 9 and 10).

The presence of *Musca* flies on the animals 7 DPT could be due to the multivarious breeding sites available for the *Musca* fly and not exclusively the dung of the treated cattle as is the case in *Haematobia*. The possibility of resistance to flumethrin in *Musca* flies also cannot be ruled out since unlike the *Haematobia* fly which has not been exposed to flumethrin, *Musca* considering its rampant nuisance activity would have been treated with flumethrin and development of resistance in the fly cannot be ruled out.

Conclusion

Based on the results obtained in this study, it is concluded that flumethrin is found to be more effective against *H. exigua* up to 4–5 weeks and hence, it can be controlled by application of flumethrin once in two months.

Declarations

Authors Contributions

PA and GP conceived and designed research. PA conducted experiments in the field. KS³, KS⁴ and PS guided the research. PA analysed data and wrote the manuscript and GP edited the manuscript. All authors read and approved the manuscript.

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Declarations

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Conflicts of interest

The authors declares that no conflicts of interest.

Ethics approval

Not applicable. This Research work was carried out under field condition.

Consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material (data transparency)

The data generated and analysed during the study are not publicly available but are available from the corresponding authors on reasonable request.

Code availability (software application or custom code)

None

This Research work was carried out under field conditions. The research protocols were regulated and approved by the Tamil Nadu Veterinary and Animal Sciences University, Chennai. *Haematobia* fly neither protected nor endangered species, hence, no specific permits were required for this study. As per the guidelines of our institutional animal care committee, approval is not required for this study since this study was conducted under field conditions in clinical cases with consent of the owner with existing proven pharmaceutical formulations (other ectoparasites).

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Figures

STUDY AREA

Figure 1

Map showing study area in Tamil Nadu

Figure 2

Haematobia infested cow having sores near median canthus of eye

Figure 3

Haematobia infested cow having sores on the neck

Figure 4

Showing grid pattern of fly infested part

Figure 5

Mouthparts shows maxillary palps as long as the proboscis (4x, Nikon E100)

Figure 6

Leg of male *H. exigua* having 6 long hairs with curled tip on the second segment of the hind tarsi (4x, Nikon E100).

Figure 7

Absence of long hairs on the second segment of the hind tarsi of *H. exigua* female (4x, Nikon E100).

Figure 8

Graph showing pre and post treatment *H. exigua* fly intensity

Figure 9

Presence of sore in the cow pre treatment

Figure 10

Healed wound sore in the cow one week post treatment (due to complete absence of *H. exigua* flies)