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Original Article

Evaluation of 40% Diazinon Impregnated Ear Tag (Patriot™) for Controlling Horn Flies and Face Flies among Cow-Calf Pairs in the United States

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Abstract

Horn flies (*Haematobia irritans irritans*) and face flies (*Musca autumnalis*) are common insects in grazing animals in most of the world. The current study was designed to evaluate the efficacy of 40% diazinon impregnated eartags (Patriot™) in reducing horn fly and face fly pressure in cow calf pairs in Missouri, USA. Seventy cow calf pairs were randomly assigned to one of two treatment groups i.e. Patriot Group and Placebo Group. On study day 0, cows in Patriot treatment group were tagged with two insecticide impregnated ear tags (Patriot Ear Tags), while the calves were administered one tag. Placebo group animals were administered placebo ear tags in a similar manner as Patriot treatment groups. Fly counts were performed on ten randomly identified cows within each group throughout the study. Beginning on Day -10, fly counts were performed three times (day -7, -3 and 0) to ensure that fly pressure was sufficient prior to Day 0. Post-treatment fly counts were performed weekly on the same 10 cows within each group. The mean horn fly counts per animal in Patriot group were below economic threshold during first 13 week of study period and were slightly above, 215.5 in week 14 and 209.6 in week 15. The highest percent face fly efficacy was observed in study week 5 which was 72.93. The results indicate that 40% diazinon impregnated (Patriot Ear Tags) were highly effective in mitigating horn fly and face fly pressure for up to 15 weeks.

Introduction

Horn flies (*Haematobia irritans irritans*) and Face flies (*Musca autumnalis*) are common insects in grazing animals in most countries of the world. The estimated cost of horn flies to the US cattle industry is USD 1.75 Billion in 2016 (adjusted to inflation from USD 1 billion losses in 1991; Swiger and Payne 2017). These losses are associated with the horn fly's requirement as a blood feeder which subsequently causes irritation, blood loss, decreased grazing efficacy, reduced weight gains, and diminished milk production in grazing animals (Kunz et al. 1991). In several studies horn flies control has been found to increase weight gains in stocker beef cattle (Harvey and Brethour 1979, Kunz et al. 1984, DeRouen et al. 1995). Additionally the intense horn flies feeding can result in diminished leather quality (Gugliemone et al. 1999). Conversely, face flies feed on lachrymal secretions of eyes and the nasal mucosa of cattle. The face fly feeding activity provides direct exposure of the face fly to the ocular conjunctiva thereby increasing the risk of transmitting the pathogen *Moraxella bovis*, the causative agent of infectious bovine kerato-conjunctivitis, or pinkeye (Glass and Gerhardt 1984). Economic losses to the cattle industry induced by infectious bovine keratoconjunctivitis were estimated at USD > 53 million annually (Byford et al. 1992). Controlling fly pressure among cattle on pasture is a common management practice in USA. The use of insecticide impregnated ear tags is an effective management practice to control horn flies and face flies in grazing animals (Williams et al. 1981).

The current study was designed to evaluate the efficacy of Patriot™ Eartags in reducing horn fly and face fly pressure in cow calf pairs in Wyaconda, Missouri, USA.

Materials and Methods

Trial Design and Cow-Calf Pair Selection

The study was designed based on recommendations of the World Association for the Advancement of Veterinary Parasitology (WAAVP) (Holdsworth et al. 2006). Seventy cow calf pairs were tentatively selected for study enrollment. The inclusion criterion was clinically healthy cow-calf pairs. Exclusion criteria consisted of animals treated with any insecticidal and endectocidal product within 90 days prior to study initiation and cows and/or calf with health issues which would preclude study completion.

Prior to the acclimatization period, 70 cow calf pairs were randomly assigned to one of two treatment groups i.e. 40% diazinon impregnated ear tag group (Patriot) and Placebo Group. Treatment groups were then randomly assigned to one of the two independent pastures based upon adequate stocking density of the cow-calf pairs in each treatment group. Stocking densities were approximately 2.4 (9,7125 square meters) and 3.6 (14,5687 square meters) acres per cow-calf per for Patriot and Placebo treatment groups respectively. Pastures were separated by 1 km to prevent animals in different groups coming into contact across fence lines. Pasture and water were provided *ad libitum* for the duration of the study.

On study day 0, cows in Patriot treatment group were ear administered two insecticide impregnated ear tags (1 in each ear Patriot Insecticide Cattle Ear Tags, Bayer Animal Health, Shawnee Mission, KS) while the calves were administered one tag (1 tag/calf) consistent with product label for optimal control and current industry practices. Placebo group animals were administered placebo ear tags (Bayer Animal Health, Shawnee Mission, KS) which did not contain insecticide in a similar manner as Patriot treatment groups (i.e. two tags/cow, 1 tag/calf). For blinding purposes, the placebo ear tags were manufactured to visually appear the same as the commercial tags used for Patriot

treatment group. On the same day (study day 0) all cows and calves were administered oxytetracycline (Bio-Mycin 200, Boehringer Ingelheim, St. Joseph, MO; 4.5 mL per 45 Kg of body weight) or Tulathromycin (Draxxin Zoetis, USA 1.1 ml/45 kg body weight) for treatment of pinkeye.

Fly counts and assessment

Fly counts were performed on ten randomly identified cows within each group throughout the study. Beginning on Day -10, fly counts were performed three times (day -7, -3 and 0) to ensure that fly pressure was sufficient (i.e. >200 flies/cow) prior to Day 0. Post-treatment fly counts were performed weekly on the same 10 cows within each group. During each fly count, three side profile and head photographs were captured from each of the 10 cows in each treatment group. The best quality photograph of the side profile and face of each animal was selected. The number of horn flies and face flies was then determined by counting the number of flies observed in each picture for each individual cow. All cow-calf pairs in each group were maintained on their respective pastures and followed for 15 weeks post-treatment administration. During week 15, ear tags were removed from all animals and the study was concluded.

Fly control efficacy was determined using Abbot's formula as per WAAVP guidelines:

$$\% \text{ Fly control} = 100 \times \frac{\text{Geometric Mean No. of Flies on 10 Animals in Untreated Control Group} - \text{Geometric Mean No. of Flies on 10 Animals in Treated Group}}{\text{Geometric Mean No. of Flies on 10 Animals in Untreated Control Group}}$$

Given that horn fly counts were only performed on one side of each animal, the number of horn flies was then multiplied by 2 to account for the number of flies on the other side of the animal. Since some animals had zero fly counts, 1 count was added to all fly counts observed prior to logarithmic transformation.

The geometric mean was calculated by log transforming the observed fly counts from each animal at every time point, averaging the logarithmic transformation values, and then used the antilog to represent the geometric mean. Horn and face fly counts were evaluated using individual Poisson generalized regression models with link log function for pre-study days and weekly evaluations. All fly counts had 1 count value added to each observation prior to analysis to account for transforming observations where no flies were observed on animals. All models included fixed effects of treatment group, study week, and potential interaction between treatment group and study week. Day 0 fly counts performed on each cow were included into the statistical model as a covariate in the weekly fly outcomes.

Results

A total of 59 cow-calf pairs were enrolled in Patriot treatment group and 11 cow-calf pairs in Placebo treatment group. One calf in Patriot treatment group suffered an injury to the right forelimb on study day 21. The injury appeared to be unrelated to products evaluated, but cow and calf were excluded from the study. No other adverse events were identified.

Horn fly counts during the pretreatment and post treatment periods in Patriot Group and Placebo group are recorded in Table 1 and 2 respectively. The fly counts in Patriot Group after tagging the animals are consistently lower than Placebo group up to 14 weeks post treatment

Pretreatment and post treatment face fly counts are shown in Table 3 and Table 4 respectively. The percent control of horn fly and face fly were calculated and presented in Table 5 and Fig. 1. The percent fly control was determined by subtracting

Table 1 Model adjusted (95 % CI) counts of horn flies (*Haematobia irritans*) by treatment group during the pre-study days (days -10, -7, -3, and 0) per adult cow.

Day	Patriot Group	Placebo Group
-10	37.00 (33.42–40.97)	160.40 (152.74–168.44)
-7	59.40 (54.81–64.37)	91.80 (86.05–97.93)
-3	156.60 (149.03–164.55)	187.80 (179.50–196.49)
0	136.20 (129.16–143.63)	214.20 (205.32–223.47)

Table 2 Model adjusted (95 % CI) count of horn flies (*Haematobia irritans*) per adult cow by treatment group and study week. The model included the covariate of Day 0 horn fly counts for each cow.

Study Week	Patriot Group	Placebo Group
1	61.60 (56.75–66.78)	80.50 (75.28–86.18)
2	100.10 (93.98–106.72)	97.00 (91.17–103.12)
3	47.40 (43.18–51.99)	45.40 (41.50–49.73)
4	25.10 (22.03–28.51)	138.30 (131.36–145.62)
5	32.80 (29.30–36.67)	88.10 (82.58–93.97)
6	33.40 (29.89–37.33)	149.30 (142.03–156.84)
7	46.30 (42.18–50.9)	208.00 (199.40–216.88)
8	42.40 (38.40–46.76)	328.20 (317.38–339.38)
9	86.40 (80.66–92.51)	261.40 (251.75–271.37)
10	49.30 (44.97–53.96)	398.60 (386.65–410.92)
11	53.60 (49.16–58.53)	303.80 (293.45–314.61)
12	158.30 (150.54–166.53)	1249.50 (1227.88–1271.55)
13	148.50 (140.98–156.48)	1527.90 (1503.87–1552.41)
14	215.50 (206.35–225.00)	1304.80 (1282.69–1327.36)
15	209.60 (200.64–219.04)	115.10 (108.76–121.78)

the geometric mean of the number of flies in Patriot treatment group from the geometric mean of the number of flies in the untreated Placebo treatment group and dividing by the geometric mean of the number of flies in the untreated Placebo treatment group.

Discussion

The detrimental effect of biting and nuisance flies on cow-calf performance is documented in the peer-reviewed literature (Kunz et al. 1991, Mays et al. 2014). However, insecticide impregnated ear tags are effective management tools to control horn and face flies on cattle kept on pasture (Williams et al. 1981). Patriot Ear tags are currently labeled for the control of horn flies for up to five months and to aid in the control of face flies.

A minimum of 200 horn flies are considered to be sufficient to lower weight gain in beef cattle (Kunz et al. 1991). Although performance parameters are not reported here, it is pertinent to note that throughout the 15 week study period, horn

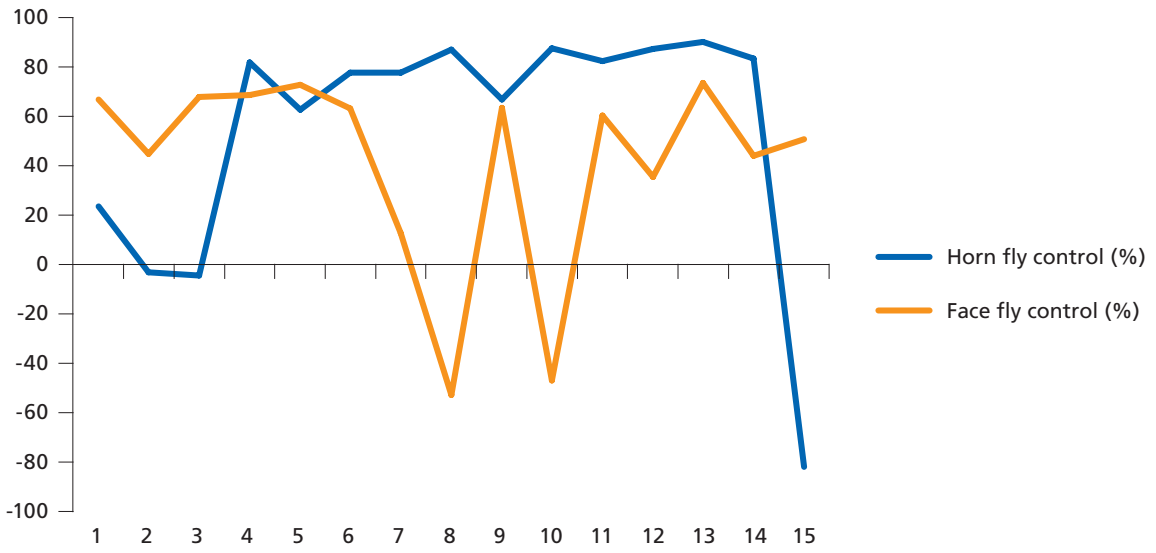

Fig 1 Horn fly (*Haematobia irritans*) and face fly (*Musca autumnalis*) control percent by treatment group and study week.

Table 3 Model adjusted (95 % CI) count of face flies (*Musca autumnalis*) by treatment group during the pre-study days (days -10, -7, -3, and 0) per adult cow.

Day	Patriot Group	Placebo Group
-10	7.10 (5.63–8.96)	12.80 (10.76–15.22)
-7	8.70 (7.05–10.73)	4.50 (3.36–6.03)
-3	8.40 (6.78–10.4)	9.70 (7.95–11.84)
0	13.60 (11.50–16.09)	14.10 (11.95–16.63)

fly counts among the cow-calf pairs allocated to the Placebo group were at or above this threshold > 50 % of the time during the 15 week study period (i.e. weeks 7–14; Table 2).

In contrast, cow-calf pairs administered Patriot Ear tags displayed sufficient control of horn flies throughout the study. Another notable observation is that among cow-calf pairs administered Patriot tags compared to the placebo tags, the maximum percent control of horn flies (90.28 %) and face flies (73.68 %) was observed in week 13 suggesting that efficacy may remain high even in cases where the fly burden is observed several weeks after application.

It should be noted that a sudden reduction in fly numbers was observed in week 15 among cow-calf pairs in the placebo group resulting in a drop in calculated efficacy. The same drop in numbers was not observed in the Patriot tag group. Further investigation into this sudden decline in fly numbers was unproductive.

Face fly numbers observed on the cattle were low throughout the study. Despite this finding and the relatively small amount of time face flies spend on

Table 4 Model adjusted (95 % CI) count of face flies (*Musca autumnalis*) per adult cow by treatment group and study week. The model included the covariate of Day 0 face fly counts for each cow.

Study Week	Patriot Group	Placebo Group
1	4.80 (3.48–6.50)	14.50 (12.24–17.15)
2	10.40 (8.48–12.68)	18.80 (16.23–21.76)
3	7.70 (6.04–9.72)	23.90 (20.99–27.20)
4	6.20 (4.71–8.06)	19.80 (17.16–22.83)
5	4.90 (3.57–6.61)	18.10 (15.58–21.01)
6	6.70 (5.15–8.62)	18.20 (15.67–21.12)
7	7.60 (5.96–9.61)	8.70 (6.95–10.84)
8	15.90 (13.52–18.63)	10.40 (8.49–12.70)
9	10.20 (8.30–12.47)	28.00 (24.85–31.54)
10	12.50 (10.39–14.97)	8.50 (6.77–10.62)
11	6.40 (4.89–8.29)	16.20 (13.81–18.98)
12	10.90 (8.93–13.23)	16.90 (14.46–19.73)
13	6.50 (4.98–8.4)	24.70 (21.75–28.05)
14	11.10 (9.12–13.45)	19.80 (17.16–22.83)
15	3.60 (2.44–5.14)	7.30 (5.69–9.29)

Table 5 Horn fly (*Haematobia irritans*) and face fly (*Musca autumnalis*) control percent by treatment group and study week.

Study Week	Horn fly percent control	Face fly percent control
1	23.48	66.90
2	-3.20	44.68
3	-4.41	67.78
4	81.85	68.69
5	62.77	72.93
6	77.63	63.19
7	77.74	12.64
8	87.08	-52.88
9	66.95	63.57
10	87.63	-47.06
11	82.36	60.49
12	87.33	35.5
13	90.28	73.68
14	83.48	43.94
15	-82.10	50.68

the host (compared to horn flies), face fly control was observed among cow-calf pairs administered the Patriot tag relative to the placebo tag.

In summary, these data indicate that Patriot Ear tags were highly effective in mitigating horn fly and face fly pressure for up to 15 weeks.

Ethical approval

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All procedures performed were in accordance with the ethical standards of the institution or practice at which the study was conducted.

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Conflict of Interest

Chandra Bhushan is currently employed by Bayer Animal Health and Jason Nickell is a former employee of Bayer Animal Health.

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