EVALUATION OF CHEMICAL TREATMENTS TO PREVENT *CULICOIDES* SPP. (DIPTERA: CERATOPOGONIDAE) FEEDING ON CATTLE IN THE NORTHERN TERRITORY

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Summary

This trial aimed to evaluate the efficacy of the registered buffalo fly treatments, deltamethrin, permethrin and fenvalerate in preventing attack on cattle by *Culicoides* spp. All chemicals significantly reduced the numbers of unfed *C. actoni* Smith, *C. brevitarsis* Kieffer, *C. fulvus* Sen and Das Gupta, and *C. peregrinus* Kieffer collected from the cattle 8 - 60h after application. The chemicals also reduced the number of bloodfed *C. actoni* and *C. peregrinus* for the same period. *C. actoni* and *C. peregrinus* were the most abundant species and there were no apparent differences in their susceptibility to these compounds. These chemicals, therefore, may be a useful as part of a risk reduction strategy for transporting cattle through areas of possible arbovirus activity.

Keywords: *Culicoides, chemical treatments, arboviruses, cattle*

INTRODUCTION

The use of chemical treatments has been identified as a potential risk reduction measure to enable the export of cattle from northern ports of Australia to arbovirus sensitive markets. A significant reduction in infection with bluetongue virus (BLU) had previously been found to be associated with treatment of cattle with deltamethrin (Melville *et al.* 2000).

Culicoides brevitarsis Kieffer is the major species of concern in the transmission of BLU within Australia as it is the most widespread bluetongue virus vector. However, three other suspected BLU-vector species (*C. actoni, C. fulvus* and *C. wadai*) and several other *Culicoides* spp. have been detected in the vicinity of the live cattle loading ports in the Northern Territory (National Arbovirus Monitoring Program reports). It is important to evaluate the efficacy of chemicals for protection of livestock against attack by these *Culicoides* species.

The aim of this study was to further evaluate the efficacy of chemicals registered for buffalo fly against various *Culicoides* species infesting cattle in the Northern Territory.

MATERIAL AND METHODS

Three trials were conducted between March and June 1999 at Beatrice Hill Farm (12.39°S, 131.20°E) which is located approximately 60 km south east of Darwin on the flood plain of the Adelaide River.

Forty cross-bred Brahman type steers weighing between 200 and 400 kg were allocated to four equal treatment groups according to colour and weight. Each group had a comparable distribution of dark and light colours and an equivalent average weight. Three groups were treated with deltamethrin (25 g/L), permethrin (40 g/L) and fenvalerate (200 g/L) respectively and a fourth group was untreated. Each group received the same chemical treatment on three occasions with a 15 day interval between the first two treatments and a 46 day interval between the second and third treatments. Treatments were applied between 0800 h and 0900 h at the start of each trial. Chemicals were applied according to the label recommendation for buffalo fly treatment. Each group was penned separately for assessment or held in separate paddocks between samples or treatments to prevent the transfer of chemicals between groups.

Insect collections from animals were made by mechanical aspiration into a gauze bag. Sampling commenced from the control group each evening between 1700 h and 1800 h starting on the first day of treatment with chemicals. When *Culicoides* spp. were detected, each group of animals was vacuumed for 5 minutes and the catches stored separately. Two operators made simultaneous collections and the order of sampling was rotated randomly between collections. Collections were made at 15 - 30 minute intervals, ceasing each evening between 2000 h and 2230 h depending on the numbers of *Culicoides* spp. being caught. The procedure was repeated for 3 days. Sampling recommenced at 0400 h and continued

until about 0900 h the next day on five of the nine mornings. Collections were chilled, briefly checked for the presence of *Culicoides* species under a binocular microscope and then stored in alcohol. Total bloodfed and unfed *Culicoides* spp. were sorted and counted by species, parity, gravidity and sex.

Statistical analysis

Data were considered for four species of *Culicoides*: *C. actoni* Smith, *C. brevitarsis* Kieffer, *C. fulvus* Sen and Das Gupta and *C. peregrinus* Kieffer and each was analysed individually. Additionally, data from a complex of seven species (as above plus *C. bundyensis* Lee and Reye, *C. marksi* Lee and Reye and *C. oxystoma* Kieffer) were combined for separate analysis.

The data were divided into evening and morning collections of unfed and bloodfed *Culicoides* spp. and each was analysed separately. Generalised linear models (GLM) were fitted using Genstat for Windows to test the effects of chemical treatments and the time (1 to 3 days) after application. The interaction between time after application and the chemical treatment was also tested but was shown to be non-significant in all cases. The GLM fitted had a Poisson distribution with the canonical log link. The change in deviance ratio was assessed using the F-test. Where significance was found, differences were detected with pairwise t-tests.

Data derived from the evening collections in the three trials were combined and compared at different times after the application of the chemicals using an analysis of variance on log transformed data (Finney 1952). These data were also expressed as percentage reductions from their respective untreated controls and the results used to indicate an effect on contact (based on the reduction of all parity stages combined) or feeding (based on the reduction of the bloodfed parous stage only) on animals.

RESULTS

The species composition changed over the period of the trial. At the end of March, *C. actoni* was only present in very low numbers but had become the dominant species by the end of the trials. *C. peregrinus* dominated the first collections in late March, but was only present in low numbers in June. These species comprised most of the insects collected. *C. actoni* accounted for 42% and 28% of the total bloodfed and unfed numbers respectively and *C. peregrinus* accounted for 43% and 62% of the total bloodfed and unfed numbers respectively. *C. brevitarsis, C. fulvus, C. marksi, C. bundyensis* and *C. oxystoma* did not constitute a large component of any collection.

Table 1. Pairwise differences for chemical treatments on four *Culicoides* species monitored in the evening and morning for three days on three occasions in the Northern Territory.

Species and Feeding Status	Predicted mean number collected (standard error)			
	Control	Deltamethrin	Permethrin	Fenvalerate
Evening collections				
C. actoni - bloodfed	58.2 (7.1)a	10.3 (3.0)b	19.0 (4.1)b	16.2 (3.8)b
C. action - unfed	960.1 (120.4)a	425.8 (80.1)b	453.7 (82.7)b	423.3 (79.9)b
C. peregrinus - unfed	1216 (244)a	358 (132)b	514 (159)b	444 (147)b
C. brevitarsis - unfed	23.1 (3.6)a	0.44 (0.5)b	1.5 (0.9)b	1.6 (1.0)b
C. fulvus - unfed	39.4 (5.6)a	16.0 (3.6)b	19.9 (4.0)b	19.2 (3.9)b
Morning collections				
C. actoni - bloodfed	11.3 (2.4)a	1.3 (0.8)b	0.6 (0.6)b	1.7 (0.9)b
C. actoni - unfed	157.5 (34.3)a	44.8 (18.3)b	47.1 (18.7)b	19.7 (12.2)b
C. peregrinus - bloodfed	101.2 (20.3)a	21.6 (9.4)b	24.8 (10.1)b	9.4 (6.2)b
C. peregrinus - unfed	2461.6 (172.4)a	937.2 (106.4)b	1015.6 (110.8)b	460.8 (74.6)c

Means in rows with different letters are significantly different using pairwise t-tests ($P < 0.05$).

Table 2. Mean number of four *Culicoides* spp. collected in the evening from cattle treated with three insecticides at different times after treatment. The percentage reduction of each mean from their respective controls is given in brackets as an indication of the inhibition of contact with animals due to the chemical.

Hours after treatment	Mean Number Collected (% reductions from control)			
	Control	Deltamethrin	Permethrin	Fenvalerate
C.actoni				
8-13	1184	873 (26)	575 (51)	505 (57)
32-37	911	226 (75)	441 (51)	520 (43)
56-60	960	210 (78)	402 (58)	293 (69)
C.peregrinus				
8-13	762	127 (83)	439 (42)	624 (18)
32-37	2269	343 (85)	676 (70)	202 (91)
56-60	645	631 (2)	439 (32)	524 (19)
C. fulvus				
8-13	43	21 (52)	25 (42)	33 (23)
32-37	54	14 (73)	21 (60)	9 (83)
56-60	24	13 (46)	15 (38)	15 (35)
C. brevitarsis				
8-13	37	0 (100)	2 (95)	0 (100)
32-37	35	1 (97)	2 (94)	2 (94)
56-60	5	0 (100)	1 (80)	4 (20)

Blood-fed insects comprised a small proportion of the total collections (Table 1). The proportion was 2-3% in most collections regardless of treatment or species.

All chemical treatments significantly reduced the numbers of *C. actoni* (bloodfed and unfed) and *C. peregrinus* (unfed) from evening and morning collections (Table 1). Bloodfed *C. peregrinus* in the evening were not significantly different. Each chemical also reduced numbers of unfed *C. brevitarsis* and *C. fulvus* in evening collections. Fenvalerate performed significantly better than the other chemicals on unfed *C. peregrinus* in the morning collections.

Mean numbers of *C. actoni, C. peregrinus, C. fulvus* and *C. brevitarsis* over three time periods after treatment with chemicals are given in Table 2. No significant differences between time periods were detected for any of the chemical treatments or species. Percentage reductions from the control ranged from 2 to 100 percent. In the period 8 - 60 h after applying the chemicals, numbers of all species combined were 67% (deltamethrin), 59% (permethrin) and 62% (fenvalerate) less than those in the untreated controls.

Means of bloodfed *C. actoni* and *C. peregrinus* over three time periods after treatment with chemicals are given in Table 3. No significant differences between time periods were detected for any of the chemical treatments or species. Percentage reduction from the control ranged from an increase in *C. peregrinus* numbers to a 93% reduction in *C. actoni.* In the period 8 - 60 h after applying the chemicals, numbers of all species combined were 80% (deltamethrin), 74% (permethrin) and 74% (fenvalerate) less than those in the untreated controls.

DISCUSSION

Some species for which results were obtained have

Table 3. Mean number of bloodfed individuals from two species of *Culicoides* collected in evenings from cattle treated with three insecticides at different times after treatment. The percentage reduction of each mean from their respective controls is given in brackets as an indication of the inhibition of feeding on animals due to the chemical.

Hours after treatment	Mean Number Collected (% reductions from control)			
	Control	Deltamethrin	Permethrin	Fenvalerate
C. actoni				
8-13	80	24 (70)	19 (76)	17 (79)
32-37	58	4 (93)	24 (59)	13 (78)
56-60	36	4 (89)	14 (61)	19 (47)
C. peregrinus				
8-13	6	3 (50)	2 (67)	1 (83)a
32-37	18	15 (17)	5 (72)	2 (89)a
56-60	3	8 (-167)	5 (-67)	16 (-81)b

Means in blocks with different letters are significantly different ($P < 0.05$). Values with no letters are not significantly different.

been implicated as possible vector species of arboviruses including bluetongue (*C. fulvus, C. actoni, C. brevitarsis* - Standfast *et al.* 1979), Akabane (*C. brevitarsis* - St George *et al.* 1978) and bovine ephemeral fever (*C. brevitarsis* - Cybinski and Muller 1990) viruses. Treatment of cattle with deltamethrin, permethrin or fenvalerate significantly reduced *Culicoides* spp. numbers and thereby the risk of these vectors feeding on cattle.

The lack of a significant reduction in bloodfed numbers of *C. peregrinus* in evening collections by any of the chemicals indicated that the response of different *Culicoides* spp. to these chemicals is not necessarily uniform. Nonetheless, four species that were analysed individually or when their data were combined with other species were significantly reduced by all of the chemicals tested. This suggested that those species not included in individual analyses might also be reduced in number by the chemicals.

It was not possible to conclude from these trials how the chemicals exerted their effects. The apparent reductions in contact and feeding may have been due to repellent or toxic effects. It appeared from the number of bloodfed individuals collected that the chemicals were not exerting any specific effect on blood-feeding once the insects had landed on the cattle.

Chemicals such as those trialed here may not be completely effective by themselves but demonstrated sufficient efficacy to suggest that they could be used as part of a scientifically-based risk management strategy that would allow the transport of cattle through areas of possible arbovirus and other midge-borne diseases. Other uses may include the protection of stud cattle in *Culicoides* infested areas.

ACKNOWLEDGMENTS

Carole Wright assisted Diana Pinch with the statistical analyses. Eric Cox and Ed Conway assisted with the insect collection at Beatrice Hill Farm. Funding for this work was provided by the Australian Quarantine and Inspection Service.

REFERENCES

Cybinski, D.H. and Muller, M.J. (1990). Isolation of arboviruses from cattle and insects at two sentinel sites in Queensland, Australia, 1979-85. *Aust. J. Zool.* **38**: 25-32.

Finney, D.J. (1952). Statistical method in biological assay. Charles Griffin and Company Limited, London.

Melville, L.F., Hunt, N.T., Bellis, G. and Pinch, D. (2000). An assessment of insecticides to minimise the transmission of arboviruses in cattle. **In**: Proceedings of 8th Arbovirus Research in Australia/4th Mosquito Control Association of Australia Symposium (Brown, M., ed.). (In press).

St George, T.D., Standfast, H.A. and Cybinski, D.H. (1978). Isolation of Akabane virus from sentinel cattle and *Culicoides brevitarsis*. *Aust. vet. J.* **54**: 558-561.

Standfast, H.A., Dyce, A.L., St George, T.D., Cybinski, D.H. and Muller, M.J. (1979). Vectors of a bluetongue virus in Australia. **In**: Arbovirus Research in Australia – Proc 2nd Symp: 20-27 (St George, T.D. and French, E.L., eds.). CSIRO and QIMR, Brisbane.