

The effect of deltamethrin pour-on applied to cattle on the transmission of bovine trypanosomosis

P. Van den Bossche ^{1*} L. Duchateau ²

Key words

Glossina - Cattle - Insect control - Deltamethrin - Application method - Trypanosomosis - Zambia.

Summary

A trial to evaluate the effect of monthly deltamethrin pour-on treatments on the tsetse's feeding response and, consequently, the incidence of tsetse-transmitted trypanosomosis in deltamethrin-treated and untreated cattle was conducted in Zambia. During a period of 14 consecutive weeks the two-weekly trypanosomosis incidence and packed cell volume of deltamethrin-treated and untreated herds, herded in the same area, were compared. No significant differences were found. It is concluded that the reported effects of deltamethrin treatments on trypanosomosis incidence are a result of reduced tsetse challenge due to a decline in tsetse density in surrounding areas and not of the direct effect of deltamethrin treatments on the tsetse's feeding response. This control method will, therefore, be most effective in those areas where the tsetse population density can be sufficiently reduced to significantly affect disease transmission.

■ INTRODUCTION

Tsetse flies (*Glossina* spp.) and trypanosomosis, the disease they transmit, have been successfully controlled by applying insecticide to cattle or to artificial baits, termed targets (1, 7, 10). With both types of application the disease transmission is reduced due to a slow decline of tsetse densities in the surrounding areas, and hence a gradual reduction in challenge. However, there is some evidence that disease transmission can also be reduced more directly and immediately by the inhibition of the flies' feeding responses on insecticide-treated animals (2, 20). Other evidence contradicts this (3, 6, 17).

It is necessary to clarify the importance of this direct effect of insecticide treatments on the tsetse's feeding response or trypanosomosis transmission because it is the one which could offer an immediate benefit to the farmer who treats his cattle, irrespective of whether the cattle are treated in adjacent areas or irrespective of its effect on the tsetse population density (4). By

contrast, the effect that depends on the decline of tsetse density cannot be achieved by one farmer alone. If cattle in nearby areas are untreated or treated only sporadically the flies will persist there, allowing a steady stream of flies to invade the areas where cattle are treated properly. In this case, deltamethrin treatments will have less effect on the incidence of trypanosomosis in treated cattle. A related problem occurs when cattle are kept immediately adjacent to a game reserve from which tsetse can continuously invade.

The present work elucidated the importance of the direct effect by studying the incidence of trypanosomosis in groups of deltamethrin-treated and untreated cattle herded in the same area and subject to a similar and constant tsetse challenge.

■ MATERIALS AND METHODS

The trial was conducted between August and December 1992 in the Katete District, Eastern Province, Zambia (31°50' E and 13°05' S). The area is on the border of the eastern plateau at an elevation of approximately 900 m above sea level. It is highly cultivated and carries approximately 5 head of cattle/km² together with goats, pigs, dogs and few game animals (mainly small antelopes). The prevalence of bovine trypanosomosis is high and constitutes a serious constraint to rural development. Only *Glossina morsitans morsitans* Westwood 1850 was present taking 75% of its blood meals from cattle (19).

1. Regional Tsetse and Trypanosomosis Control Programme (RTTCP), PO Box A560, Avondale, Harare, Zimbabwe

Tel: 263 4 707683; Fax: 263 4 722684

E-mail: petervdb@rttcp.icon.co.zw

2. International Livestock Research Institute (ILRI), PO Box 30709, Nairobi, Kenya

* Corresponding author

Trypanosomiasis incidence in deltamethrin-treated cattle

Thirty randomly selected adult oxen (Ngoni breed), aged between 1.5 and 3 years, were divided into two herds; a control herd and one treated with deltamethrin pour-on (Spoton[®], Coopers) of 15 and 12 animals, respectively. At the start of the trial (week 0), all animals were ear-tagged and treated with diminazene aceturate (Berenil[®], Hoechst) at 7.0 mg/kg body weight. Deltamethrin pour-on (Spoton[®], 1% deltamethrin active ingredient) was applied to all animals of the treated herd, in a line along each side of the animal at a dose of 10 ml/100 kg body weight, using a T-shaped hand applicator. Pour-on treatment was repeated at 4-week intervals (weeks 0, 4, 8, 12 and 16).

To avoid risk of contamination, oxen treated with deltamethrin pour-on were kept as one group and kraaled together. All animals were exposed to the same natural field challenge of tsetse by herding them in the same area (approximately 10 km²). Different herdsmen looked after the treated and the untreated groups and kept the two herds separate.

To allow for a persistent effect of a double dose of diminazene aceturate (7 mg/kg) all animals were considered to be protected during the first four weeks after the initial treatment. Trypanosomiasis incidence in both herds was calculated at two weekly intervals from week 5 onwards. On each occasion, ear vein blood of all animals was examined for trypanosomes using the hematocrit centrifugation technique (Woo method) and the packed cell volume (PCV) percentage was measured (12). Since diminazene aceturate resistance had not been reported in the trial area, trypanosomal infections were treated with diminazene aceturate at 3.5 mg/kg body weight. Animals given this dose of diminazene were considered to be protected during the subsequent two weeks and were therefore excluded from the next calculation of incidence.

PCV of treated and untreated cattle were compared using a t-test (5). A one-sided Fisher-exact test (5) was used to test whether the trypanosomiasis incidence in the deltamethrin-treated herd was significantly lower compared to the incidence in the untreated herd (Statxact, Cytel Software Co).

The apparent density of tsetse in the herds' grazing area was monitored using five epsilon traps baited with acetone (at a release rate of 200 mg/h) (8). Traps were sited in *Combretum*- and *Brachystegia*-woodland. In addition, five epsilon traps (control traps) were deployed 10 km south of the grazing area. Trap cages were emptied daily. Live flies were dissected to determine trypanosome infection rates (9).

■ RESULTS

In both areas, the apparent density of tsetse followed the normal seasonal pattern with a low apparent density during the dry season (August-November) and a sudden increase at the beginning of the rainy season (December) (figure 1). Apparent density in the grazing area was similar to the apparent density outside the grazing area. This is not surprising considering the low number of deltamethrin-treated cattle in the trial area.

The tsetse infection rate during the trial period increased gradually from 0.63 to 2.5%. A total of 62.5% of the trypanosomal infections in tsetse were *congolense*-type, the remaining being *vivax*-type.

The two-weekly trypanosomiasis incidence (weeks 5-19) in the deltamethrin-treated and untreated herds is shown in figure 2. The first trypanosomal infection was detected seven weeks after the onset of the trial. No trypanosomal infections were detected in

week 11 in the control herd and weeks 7 and 17 in the deltamethrin-treated herd. Trypanosomiasis incidence varied considerably between herds and between weeks. The average two-weekly trypanosomiasis incidence, however, was 8.1 and 7.8% for the control and deltamethrin-treated herds, respectively. A total of 16 trypanosomal infections were detected. *Trypanosoma congolense* accounted for the majority (87.5%) of the infections. The remaining 12.5% was attributed to *T. vivax*. The probabilities for the null hypothesis of no difference between the trypanosomiasis incidence in the deltamethrin-treated and untreated herds are shown in table I. For none of the weeks the difference between the incidence of trypanosomal infections is significant.

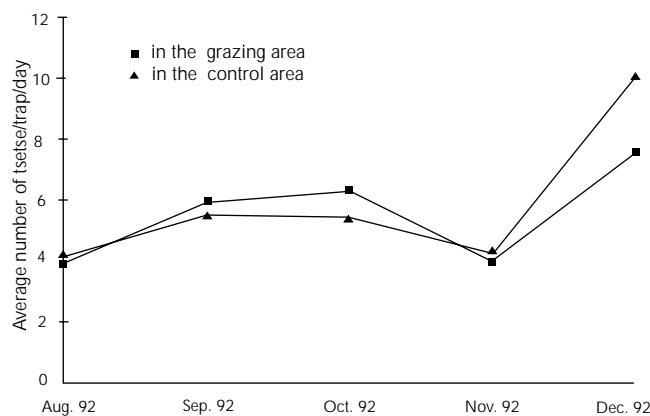


Figure 1: Monthly apparent density of tsetse in the grazing and control areas.

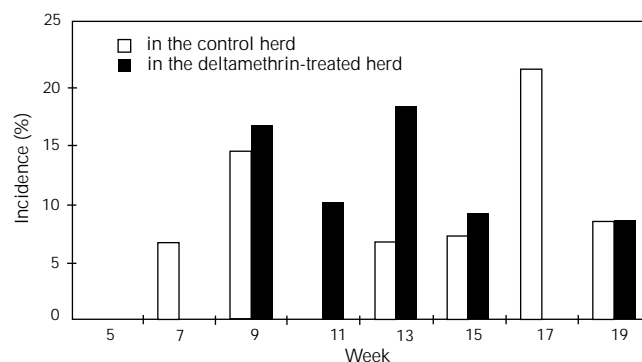


Figure 2: Two-weekly trypanosomiasis incidence in the control deltamethrin-treated herds.

Table I

Two weekly incidence of trypanosomal infections in deltamethrin-treated and untreated herds and significance of Fisher-exact test

Week	Control herd		Deltamethrin herd		p-value
	Infected	Not infected	Infected	Not infected	
7	1	14	0	12	1.00
9	2	12	2	10	0.64
11	0	13	1	9	0.44
13	1	14	2	9	0.38
15	1	13	1	10	0.70
17	3	11	0	11	1.00
19	1	11	1	11	0.76

The mean PCV (week 5-19) is presented in figure 3. The PCVs of both herds decreased gradually from an average of 32.8% in week 5 to an average of 26.6% in week 15. From week 17 onwards the average PCV increased, reaching 28.2% in week 19. None of the difference between average PCV of untreated and deltamethrin-treated herds was statistically significant ($p < 0.05$).

■ DISCUSSION

During the three-month observation period, the incidence of tsetse-transmitted trypanosomosis was never statistically lower in the deltamethrin-treated herd compared to the untreated herd. This lack of association between deltamethrin treatments and disease incidence and the variations in the incidence of trypanosomosis between herds and between samplings could be due to the low sensitivity of the parasitological diagnostic methods to detect trypanosomal infections (13). Such low sensitivity could lead to the misclassification of non-diseased animals and consequently affect parasitological incidence. This low diagnostic sensitivity is, however, non-differential and cannot affect the degree of association (18). It can nevertheless cause substantial variations in the parasitological incidence of trypanosomosis between herds and between consecutive samplings.

The low sensitivity could partly be compensated for by measuring indirect effects of trypanosomosis in both herds. A major characteristic of bovine trypanosomosis is anemia (11). Reliable indicators of anemia are PCVs (15). Significant differences between herd PCVs could therefore be used as an additional indicator of trypanosomal infections and tsetse challenge. No significant differences were observed between the average two weekly PCVs of the deltamethrin-treated and untreated herds. The gradual decrease in PCV during the first 15 weeks of the trial followed by an increase during the last four weeks was attributed to seasonal changes in the pasture condition (16).

According to the parasitological incidence and PCVs, there is no difference between the incidence of tsetse-transmitted trypanosomosis in deltamethrin-treated and untreated herds.

Any repellent or irritant effect of the deltamethrin pour-on, applied at the dose rate and treatment interval used in this trial, affecting the preference of tsetse for either treated or untreated animals cannot be excluded from the current experimental set-up. Nonetheless, results indicate that even if such effects do occur, they are too small to reduce the trypanosomosis incidence to a level that would be a direct benefit accruing to the owners of treated animals.

Consequently, the effect of deltamethrin-treatment of cattle on the incidence of tsetse-transmitted trypanosomosis observed in other experiments or control campaigns seems to be a result of its effect on the population density of tsetse or tsetse challenge rather than its direct effect on the tsetse's feeding response. Successful control of tsetse-transmitted trypanosomosis using deltamethrin-treated cattle (at a dose rate of 10 ml Spoton®/100 kg body weight and at monthly treatment intervals) will, therefore, depend on the level of induced tsetse mortality and tsetse invasion pressure. The use of this tsetse control method in areas where, due to whatever reason, the tsetse population density cannot be sufficiently lowered to reduce disease challenge will not result in a decline in trypanosomosis incidence.

Trypanosomosis incidence is determined by various host and vector related parameters (14). Calculated disease transmission thresholds and basic rates of reproduction emphasize the difficulty

Incidence de la trypanosomose chez des bovins traités à la deltaméthrine

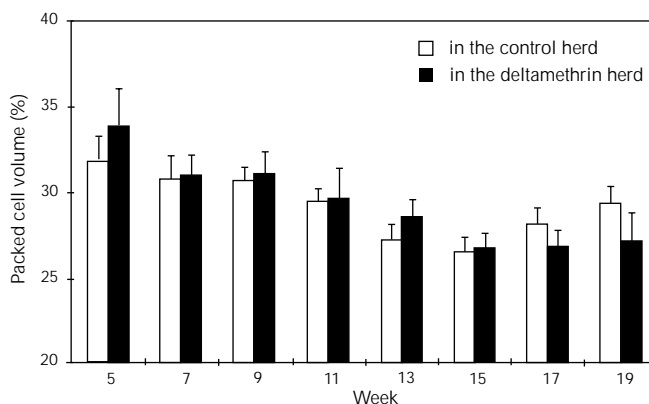


Figure 3: Mean two-weekly PCV-% (\pm s.e.) in the control and deltamethrin-treated herds.

of controlling trypanosomosis caused by *T. vivax* or *T. congolense* by anything other than almost complete control of the vector (14). Consequently, application of pyrethroid-insecticides to hosts or stationary baits will only affect the incidence of trypanosomosis when the tsetse population density has been significantly reduced.

Acknowledgments

We thank the Director and Assistant Director of the Department of Veterinary and Tsetse Control Services, Zambia, for their support. Mr. J. Chitalu is kindly acknowledged for supervising the field work. We are grateful to Dr. G. Vale for reading and criticizing the manuscript. The work was supported by the Belgian Development Cooperations through the Animal Disease Control Project (Chipata, Zambia).

REFERENCES

- BAUER B., AMSLER-DELAFOSSÉ S., CLAUSEN P.H., KABORE I., PETRICH-BAUER J., 1995. Successful application of deltamethrin pour-on to cattle in a campaign against tsetse flies (*Glossina* spp.) in the pastoral zone of Samorogouan, Burkina Faso. *Trop. Med. Parasitol.*, **46**: 183-188.
- BAUER B., KABORE I., PETRICH-BAUER J., 1992. The residual effect of deltamethrin Spot On when tested against *Glossina palpalis gambiense* under fly chamber conditions. *Trop. Med. Parasitol.*, **43**: 38-40.
- BAYLIS M., MBWABI A.L., STEVENSON P., 1994. The feeding success of tsetse flies, *Glossina pallidipes* (Diptera: Glossinidae), on oxen treated with pyrethroid pour-ons at Galana Ranch, Kenya. *Bull. Entomol. Res.*, **84**: 447-452.
- ECHESSAH P.N., SWALLOW B.M., KAMARA D.W., CURRY J.J., 1996. Willingness to contribute labor and money to tsetse control: application of contingent valuation in Busia District, Kenya. *World Dev.*, **25**: 1-15.
- FISHER R.A., 1954. Statistical methods for research workers. Edinburgh, UK, Oliver and Boyd, 356 p.
- GOUTEUX J.P., LE GALL F., GUILLERME J.M., DEMBA D., 1996. Traitement épicutané (pour-on et spot-on) du bétail contre *Glossina fuscipes fuscipes* en République centrafricaine. *Vet. Res.*, **27**: 273-284.
- GREEN C.H., 1994. Bait methods for tsetse fly control. *Adv. Parasitol.*, **34**: 229-291.
- HARGROVE J.W., LANGLEY P.A., 1990. Sterilizing tsetse (Diptera, Glossinidae) in the field - A successful trial. *Bull. Entomol. Res.*, **80**: 397-403.

Trypanosomosis incidence in deltamethrin-treated cattle

9. LLOYD L.L., JOHNSON W.B., 1924. The trypanosome infections of tsetse flies in Northern Nigeria and a method of estimation. *Bull. Entomol. Res.*, **14**: 225-227.
10. MEROT P., POLITZAR H., TAMBOURA I., CUISANCE D., 1984. Résultats d'une campagne de lutte contre les glossines riveraines en Burkina par l'emploi d'écrans imprégnés de deltaméthrine. *Revue Elev. Méd. vét. Pays trop.*, **37** : 175-184.
11. MURRAY M., DEXTER T.M., 1988. Anaemia in bovine African trypanosomiasis: a review. *Acta trop.*, **45**: 389-432.
12. MURRAY M., MURRAY P.K., MCINTYRE W.I.M., 1977. An improved parasitological technique for the diagnosis of African trypanosomiasis. *Trans. R. Soc. trop. Med. Hyg.*, **71**: 325-326.
13. PARIS J., MURRAY M., MCODEMBA F., 1982. A comparative evaluation of the parasitological techniques currently available for the diagnosis of African trypanosomiasis in cattle. *Acta trop.*, **39**: 307-316.
14. ROGERS D.J., 1988. A general model for the African trypanosomiasis. *Parasitology*, **97**: 193-212.
15. SAROR D.I., 1979. Classification of the anaemia of bovine trypanosomiasis. *Vet. Rec.*, **5**: 96-98.
16. SAWADOGO G.J., OUMAROU A.A., SENE M., DIOP M., 1991. Effect of poor pasture conditions and type of feeding on some biochemical values of Gobra Zebu in Senegal. *Br. vet. J.*, **147**: 538-544.
17. THOMSON M.C., 1987. The effect on tsetse flies (*Glossina* spp.) of deltamethrin applied to cattle either as a spray or incorporated into ear-tags. *Trop. Pest Manage.*, **33**: 329-335.
18. THURFIELD M., 1986. Veterinary epidemiology. London, UK, Butterworths, 128 p.
19. VAN DEN BOSSCHE P., STAAK C., 1997. The importance of cattle as a food source for *Glossina morsitans morsitans* Westwood (Diptera: Glossinidae) in Katete District, Eastern Province, Zambia. *Acta trop.*, **65**: 105-109.
20. VAN DEN BOSSCHE P., VAN HEES J., MORTELMANS J., 1987. Observations of the remnant effect of deltamethrin acaricide liquid on tsetse flies under laboratory conditions. In: Proc. 19th Meet. ISCTRC, Lome, Togo, 29 March-3 April, 1987. Nairobi, Kenya, OAU/STRC, p. 422-424.

Reçu le 23.10.97, accepté le 9.9.98

Résumé

Van den Bossche P., Duchateau L. L'effet des traitements à la deltaméthrine (*pour-on*) sur la transmission de la trypanosomose bovine

Une expérience a été menée en Zambie afin de déterminer l'effet d'un traitement mensuel à la deltaméthrine *pour-on* sur le comportement alimentaire des mouches tsé-tsé et, par conséquent, sur l'incidence de la trypanosomose qu'elles transmettent au bétail traité à la deltaméthrine et non traité. Toutes les deux semaines, pendant quatorze semaines, l'incidence de la trypanosomose et l'hématocrite de troupeaux traités à la deltaméthrine et de troupeaux témoins non traités groupés dans la même zone ont été comparés. Aucune différence significative n'a été trouvée entre les deux groupes. Il est conclu que l'effet de la deltaméthrine sur l'incidence de la trypanosomose s'explique par une baisse de la pression glosinienne due à la diminution de la densité des mouches tsé-tsé dans la zone environnante plutôt que par un changement de leur comportement alimentaire qui aurait été induit par les traitements à la deltaméthrine. L'utilisation de cette méthode de lutte doit donc être réservée aux endroits où une diminution suffisante de la densité de tsé-tsé peut se traduire par une chute du risque trypanosomien.

Mots-clés : *Glossina* - Bovin - Lutte anti-insecte - Deltaméthrine - Méthode d'application - Trypanosomose - Zambie.

Resumen

Van den Bossche P., Duchateau L. El efecto de la deltametrina por aplicación de chorreo en ganado, sobre la transmisión de la tripanosomosis bovina

Se llevó a cabo, en Zambia, un experimento para evaluar el efecto de tratamientos mensuales por chorreo de deltametrina, sobre las respuestas alimenticias de la tsetse y, consecuentemente, sobre la incidencia en la tripanosomosis transmitida por tsetse en ganado tratado y no tratado con deltametrina. Se compararon cada dos semanas, durante un período de 14 semanas consecutivas, la incidencia de tripanosomosis y el hematocrito en hatos tratados y no tratados con deltametrina, en pastoreo una misma zona. No se encontraron diferencias significativas. Se concluye que los efectos reportados de los tratamientos con deltametrina sobre la incidencia de la tripanosomosis son el resultado de una disminución del ataque de la tsetse, debido a una disminución en la densidad de tsetse en el área y no por un efecto directo de los tratamientos con deltametrina sobre la respuesta alimenticia de la tsetse. Por lo tanto, este método de control tendrá mayor efecto en aquellas áreas en las que la densidad de población de la tsetse puede reducirse suficientemente, como para afectar en forma significativa la transmisión de la enfermedad.

Palabras clave: *Glossina* - Ganado bovino - Control de insectos - Deltametrin - Método de aplicación - Tripanosomosis - Zambia.