International Scholars Journals

African Journal of Agriculture ISSN 2375-1134 Vol. 6 (1), pp. 001-004, January, 2019. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Effect of three different treatment levels of deltamethrin on the numbers of dung beetles in dung pats

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Accepted 11 December, 2018

The effect of 3 different treatment levels of the pyrethroid deltamethrin on the numbers of dung beetles (Families, Hydrophilidae, Scarabidae and Staphilinidae) were investigated. A known quantity of cow dung was thoroughly mixed with a premeasured quantity of deltamethrin that would give the required concentration. Dung was exposed in the field for 1 week, collected and washed out to determine the number of beetles. The three levels tested against the control were 0.01mg, 0.1 and 1mg of deltamethrin per litre of dung. The Hydrophilidae and Staphilinidae showed a significant difference from the control at the concentration level of 0.1 mg per litre of dung. The Scarabidae were the most sensitive to deltamethrin showing a significant difference to the control at the lowest dose of 0.01mg per litre. The research recommends that any treatment of livestock especially cattle with deltamethrin that results in dung contamination of 0.1 mg for Hydrophilidae and Staphilinidae, and 0.01 mg for Scarabidae should be reviewed where possible, particularly in those countries where pyrethroids are widely used.

Key words: Hydrophilidae, Staphilinidae, Scarabidae, Pyrethroids, Deltamethrin

INTRODUCTION

Various techniques have been used to prevent flies and other insects from settling on domestic animals especially sheep and cattle. The use of synthetic pyrethroids for the control of these biting and sucking insects on cattle has become part of farming worldwide. The ability of synthetic pyrethroids has led to a wider usage especially in some parts of the tropics where tick borne diseases can be a major problem especially in summer months (Warnes et al., 1998).

In Southern Africa, pyrethroids (deltamethrin, fluemethrin, alphacypermethrin, and cyfluthrin) are used to control tsetse flies and ticks (Vale et al., 1998). Entomological efficacy of deltamethrin has even been tried to reduce malaria incidences through the simultaneous control of mosquitoes (anopheles), ticks and tsetse flies in Ethiopia (Habtewold et al, 2004). In Zimbabwe, they are used extensively either as pour on or in plunge dips. However, pyrethroids have been noted to be lethal on non-target organisms mainly dung beetles and flies that are critical in the conversion of cattle dung into humus. Dung excreted from treated cattle was observed to contain traces of deltamethrin (GLOSSINEX manufactured by Ecomark Zimbabwe, Craster Road, Southerton, Harare) despite using recommended levels of the chemical.

Recent research work has produced conflicting reports on their effect on dung flies and beetles. Kruger et al. (1998) concluded that the number of adult beetles recovered was similar in dung from treated and untreated cattle in South Africa, KwaZulu Natal. However, Vale et al. (1998) working at Rukomichi Research Station in the Zambezi Valley in Zimbabwe, observed dead beetles in and near the dung dropped by cows treated with a pyrethroid. Analysis of the dung at the Natural Resource Institute (UK) and the Tobacco Research Board (Zimbabwe) showed that insecticide at 0.02-0.15 ppm was found in the dung up to 12 days post treatment.

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To date very little is known about the effects of deltamethrin residues in dung from treated animals especially on non-target insects. Furthermore the conflicting results and reports show that there is still need to investigate and determine the dung contamination levels, which do not kill dung beetles. The research sought to determine the effect of three levels of the pyrethroid deltamethrin on the number of surviving adult beetles.

Importance of dung beetles in the nutrient cycle

There are many animals and plants that perform a vital role in the nutrient cycle of pastures, particularly in humification of cattle dung. The organisms featuring prominently in this role are insects mainly files and beetles (Skidmore, 1991). This view is different from Putman (1983) who asserted that earthworms are the primary invertebrates of cow dung decomposition. The crucial role of the dung community is demonstrated in Australia where no native cow dung loving fauna exists. It is estimated that the un-degraded dung of five cattle removes from production one acre of land per year and considerable expense is being incurred in trying to establish a cow dung community (Skidmore, 1991). Australia, USA and the ranching areas of South America are seeking to correct the unavailability of native dung fauna through establishing sustainable cow dung communities mainly beetles. Pasture land covered by un-degraded cow is effectively non productive since research has shown that natural degradation cannot occur in the absence of insect decomposers since fossil dung pellets have been frequently found in sedimentary rocks (Skidmore, 1991).

Despite the pivotal role played by beetles in the dung humification process, they are persistently exposed to lethal chemicals as non-target insects. Pyrethroids pose the greatest danger to beetles given that they are widely used to control common tropical pests such as ticks and tsetse flies (Regional Tsetse and trypanosomiasis Control Program Report, 1997).

Effects of pyrethroids on dung beetles

Pyrethroids are known to kill beetles through disruption of the central nervous system and are known to be more potent at the larval stage.

Sustaining Beetle populations in the ecosystem

Beetles play an important role in maintaining pastures in a productive state. There is need for constant biological monitoring of beetle populations in pastures and create conditions conducive for their self-sustenance. Indiscriminate use of broad- spectrum chemicals should be minimized as this might have negative impacts on dung beetle populations. Sensitivity of beetle families to chemicals differs hence there is need to identify predominant beetle families in a given locality. This helps in determining location specific pyrethroid concentration levels that would have less detrimental to the survival of the beetles (Bath et al., 1994).

MATERIALS AND METHODS

Fresh cow-dug was collected from the dairy milking shed at Nafferton farm in Northern England in plastic buckets and carried to the experimental site. The required amount of dung was measured into an empty bucket using a 1-litre cup. The Deltamethrin was diluted first to make it possible to add accurately the small quantities required. The appropriate amount of deltamethrin (20% Suspension Concentrate) was then added and thoroughly mixed with the dung to give the required ppm for the particular treatment level.

Four Treatment levels were tested and these are shown below:

Treatment	1	0ppm per litre of dung/control
Treatment	2	0.01ppm per litre of dung
Treatment	3	0.1ppm per litre of dung
Treatment	4	1ppm per litre of dung

The dung pats were then layed out on bare ground with loose soil. Each pat contained 1 litre and these were layed out in a randomized block design with an individual and inter row spacing of 2m.

The experiment had 5 replicates for each treatment level, giving a total of 20 pats. The reduction in the replicates was due to time limitations since the method used to extract organisms from the dung after exposure was very time consuming.

The pats were left exposed for 1 week to allow establishment of the dung community at an average ambient temperature of 18 degrees Celsius and relative humidity of 65%, then collected and washed out thoroughly under running water through a series of sieves to recover larvae, pupae and adult insects. Approximately 5cm of underlying soil was also collected for washing out since some of the larvae are known to live on the interface of the pat and soil.

The washing out technique was selected as the technique for recovering insects because it is the only practical method in which the inactive stages like eggs and pupae can be removed and it is also the quickest method. Organisms have to be picked out manually.

Insects collected from each pat after washing were put in small specimen tubes with 70% alcohol for preservation and then taken to the laboratory for identification and counting.

Insects were identified using the Keys in the book, INSECTS OF THE BRITISH COW DUNG COMMUNITY by Peter Skidmore 1991 AIDGAP. Results were analyzed using two- way Analysis of variance (ANOVA) at the 5% level of significance.

RESULTS

A total of 20 dung pats were put out, left exposed and washed out yielding 809 specimens as larvae, pupae or adult beetles both dead and alive (Table 1). Results from

Table 1. Total number of insects for each treatment level

Treatment	Concentration/litre of dung	Hydrophilidae	Staphilinidae	Scarabidae
1	Control	117	283	49
2	0.01 mg	26	230	11
3	0.1 mg	3	76	2
4	1.0 mg	2	5	5

Table 2. Comparison of mean numbers of beetles in control and different treatment levels of Deltamethrin for families Hydrophilidae, Staphylinidae and Scarabidae

	Family (mean and standard deviations at 5% level)		
Level	**Hydrophilidae**	**Staphylinidae**	**Scarabidae**
1	5.2±3.033	32.2±9.524	6.600±2.074
2	3.4	27.6	1.000
3	0.2	6.4	0.000
4	0.00	0.4	0.200

Key: Levels: 1-0ppm/litre, 2-0.01ppm/litre, 3-0.1ppm, 4-1ppm/litre N=5.

the four experiments were combined for each treatment level and analyzed using one-way analysis of variance since the experiment was comparing beetle numbers across different concentrations of deltamethrin.

There was a general decline in the number of insects of the three families as the deltamethrin concentration level increased. The highest deltamethrin concentration of 1 mg per litre of dung had a strong effect as shown by the 5 insects for the Staphylinidae family compared to 283 in the control.

Hydrophilidae Family

There was a significant difference between the control and treatments 3 and 4. However, there was no significant difference between the control and treatment 2 (Table 2).

Staphylinidae Family

There was a significant difference between the control and treatments 3 and 4 but none between the control and treatment 2 (Table 2).

Scarabidae Family

There was a significant difference between the control and all the three treatments (Table 2).

DISCUSSION

A total of 809 specimens were found during the project and they consisted of 148 *Hydrophilidae* (19%), 594 *Staphilinidae* (76%), and 67 *Scarabidae* (9 %). These results are in line with those of Woodward (1993) who found 72% of the beetles were *Staphylinidae*. This agrees with Skidmore (1991)'s view that this is a large and very important family and is one of the most abundant members of the dung community in Western Europe.

Moisture content has been shown to influence colonization of dung by insects (Bath et al, 1994). However these aspects were not measured during this project. According to the results of this experiment, the minimum level of deltamethrin that had a significant reduction in the numbers of *Hydrophylidae* and *Staphilinidae* was at 0.1mg of deltamethrin per litre of dung. Beetles got exposed by contact as they moved on or through the dung pats, resulting in the assimilation of the active ingredient leading to the disruption of the nervous system and eventual death.

As shown by the results, the *Scarabidae* family was more susceptible as there was a significant difference to the control at 0.01ppm of deltamethrin per litre of dung. Since pyrethroid levels above 0.01ppm have been found in the dung of treated cattle, the problem of dung contamination should be taken seriously.

The 0.01ppm of deltamethrin per litre of dung that significantly ($p<0.05$) affected the *Scarabidae* in the project was even less than that found by Vale et al in 1998 of 0.02-0.15ppm of oxen dung treated with alphacypermethrin for up to 12 days post treatment. The fact that deltamenthrin is known to be more toxic than alphacypermethrin could possibly explain why in this experiment a lower dose of the former significantly affected the beetles.

Woodward (1993) suggests that a single cow pat appears to support more individuals and species of insects than other temporary micro-habitats. This is probably because the food supply is concentrated, both for herbivores and carnivores and any other insect larvae available for attack by parasitoids. This resource is constantly renewed through out the year and it provides a range of conditions for exploitation by many species of insects. Therefore any contamination that will negatively affect insects supported by this important micro-habitat is likely to have a major impact on various food chains and wathe environmental in general.

Conclusion

Any treatment of livestock especially cattle with deltamethrin that results in dung contamination at levels mentioned earlier should be reviewed where possible, particularly in those countries where pyrethroids are widely used. The RegionalTsetse and Trypanosomiasis Control Programme of Southern Africa, which includes Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe encourages the use of insecticide treated cattle for tsetse and tick control. There is therefore a potential for dung contamination on a large scale if the treatment ofcattle for tsetse and tick control results in dung contamination at levels above 0.01mg of pyrethroid per litre of dung, especially if the choice of pyrethroid is deltamethrin.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the contributions from The British Council, the government of the republic of Zimbabwe (GOZ) and the University of Newcastle Upon Tyne (UK).

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