An international ring test to assess effects of ivermectin application to cattle on dung fauna and dung degradation

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Background

The European Union requires an environmental risk assessment of veterinary medicinal products (VMPs) before submission on the market. Parasiticides such as anthelmintics need to be tested at higher tier (i.e., multi-species or community) levels when adverse effects on dung organisms are observed in single species toxicity tests. A paper outlining such field tests (Jochmann et al., 2011. Integ. Environ. Assess. Manag. 7:287-296) acknowledged that "the interpretation of results is generally hampered and easily confounded by a lack of knowledge about the local biological aspects of the study system, i.e., the dung pat and its associated organisms, which may vary considerably among geographic regions." Therefore, an international field ring test with ivermectin was conducted.

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Study design

- Four parallel studies were conducted in four biogeographical regions using the same overall design: (1) Lethbridge, Alberta, Canada (North American prairie environment), (2) Montpellier, France (European Mediterranean region), (3) Zurich, Switzerland (European Continental region), and (4) Wageningen, The Netherlands (European Atlantic region).
- Cattle were treated with pour-on formulation of ivermectin at 0.5 mg ivermectin/kg body weight.
- Dung was collected before treatment (Day 0) and 3, 7, 14 and 28 days after treatment (in Canada also on Day 56).
- Dung was used to conduct two parallel experiments at each field site: (1) a 'structural' experiment to investigate the effects of ivermectin on dung fauna populations and biodiversity, and (2) a 'functional' experiment to assess the effect of the treatment on dung degradation.

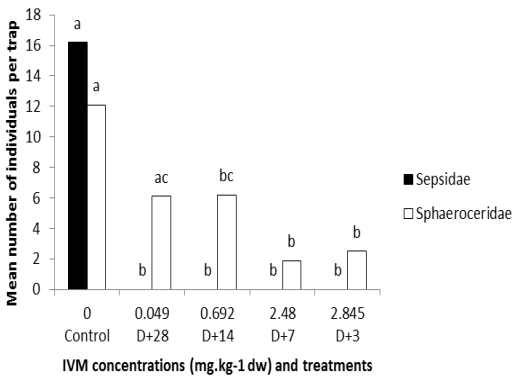

Figure 1: *Mean number of sepsid and sphaerocerid flies emerged per trap after a one-week colonisation at the study site near Montpellier, southern France. The ivermectin concentration is related to days after ivermectin treatment (Day 3, 7, 14 and 28). Mann-Whitney pairwise comparisons were conducted separately for each family between treatments; letters indicate significant differences.*

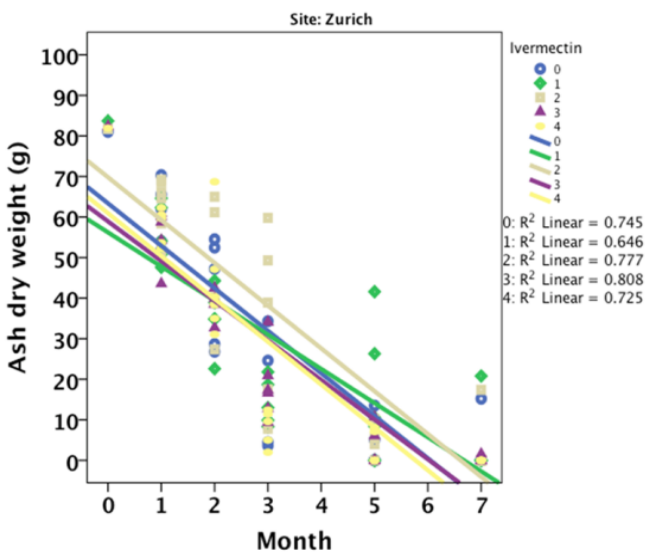

Figure 2:*Average organic matter weight of cattle dung pats containing no ivermectin (Day 0, marker 0) and dung collected from cattle on different days after ivermectin treatment (Day 3, 7, 14 and 28, markers 1-4 respectively) during four months after placing them in the field at the study site near Zurich, Switzerland.*

Results

- Ivermectin residues in cattle dung have long-term effects on various groups of dung organisms, in particular flies.
- Sepsidae are usually the most sensitive family of flies, followed by the Sphaeroceridae.
- Even dung excreted 28 days after application (and in Canada after 56 days), containing ivermectin at concentrations as low as 0.01 - 0.05 mg/kg d.w. ,can be highly toxic for various fly groups at all test sites (see Fig. 1 for an example).
- Ivermectin also negatively impacts the emergence of dung beetles from treated cattle dung, but only in dung from the first two weeks after application containing high residue doses.
- Ivermectin impact on staphylinid beetles and parasitic wasps in the field lies in between that on flies and most dung beetles.
- Effects on soil organisms (earthworms and springtails) are reported on a separate poster by Scheffczyk et al.
- The disappearance of dung organic matter varied quantitatively but not qualitatively between sites.
- At the two drier sites in Canada and southern France, the half-life ranged between 6 and 12 months. In the more temperate regions of The Netherlands and Switzerland (Fig. 2), the half-life was 2-3 months.
- Crucially, however, ivermectin treatment did not significantly affect dung degradation at any of the four sites.

Conclusions

- Despite considerable variation among the sites, the findings were qualitatively similar, so the study design is robust and hence suitable to evaluate the effects of parasiticides on dung insects under field conditions as required in higher-tier testing for risk assessment.
- The design should now be incorporated in an OECD Guidance Document.
- Laboratory tests with standard fly species predict the observed effects rather well (Blanckenhorn et al. 2013. Ecotoxicol. Environ. Saf. 89:21-28).
- With few exceptions, standard toxicity tests with dung beetle species demonstrate effects at lower concentrations than those observed in the current field experiments.
- There is a need for more ecological information on dung fauna species. Such information could be stored in a central database. It enhances the interpretation of field results and may ultimately contribute to ecological modelling of parasiticide impacts and especially recovery of field populations.

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