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African horse sickness – Protective measures to limit host-vector contact

An overview of *Culicoides* biology, ecology and vector status.

Methods of assessing protective measures

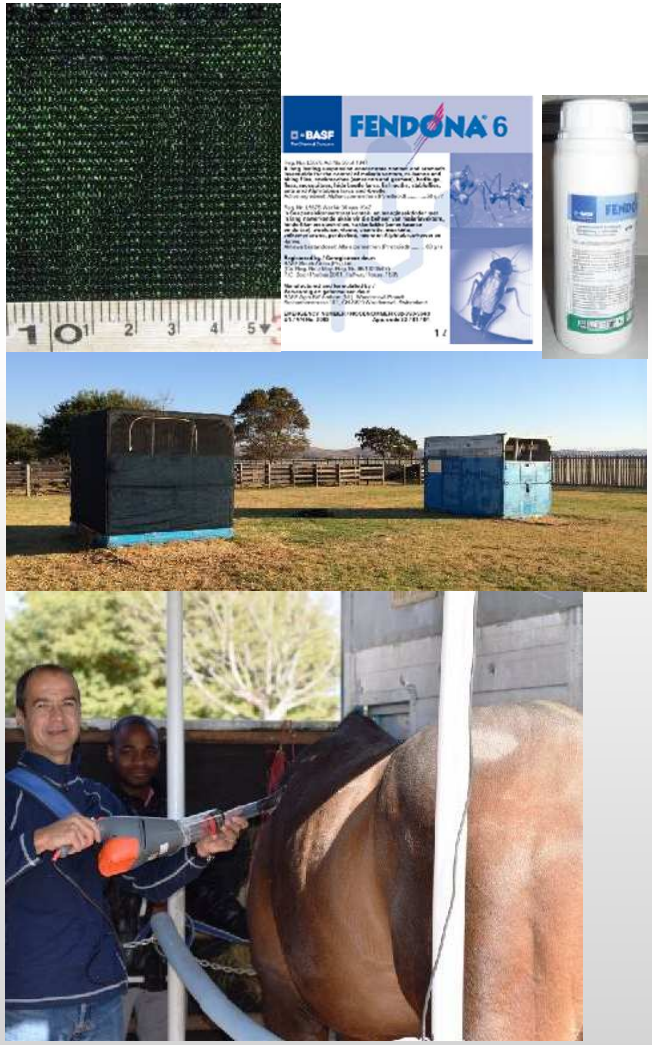
- Protective measures in scope: Barriers, insecticides, repellents
- Method of assessing efficacy
  - Bioassays
  - Light traps
  - Animal-baited tent traps
  - Direct host aspiration
- Assessment endpoints
  - Midge mortality/ blood-feeding
  - Midge numbers/ abundance
  - Attack/ biting rates
- Limitations of variable results

Stabling with untreated mesh

- Stabling alone will not adequately protect horses (e.g. endophilic midge species enter stables)
- Stabling with untreated mesh (1-4 mm) in South Africa
  - 14X reduction in *C. imicola* and *C. bolitinos* entering stables (Meiswinkel et al. 2000)
- Stabling with polypropylene mesh (0.2 mm^2 aperture) in Switzerland
  - Reduced midges collected in stable/paddock, group and stable housing by 98%, 85% and 67%, respectively (Lincoln et al. 2015)

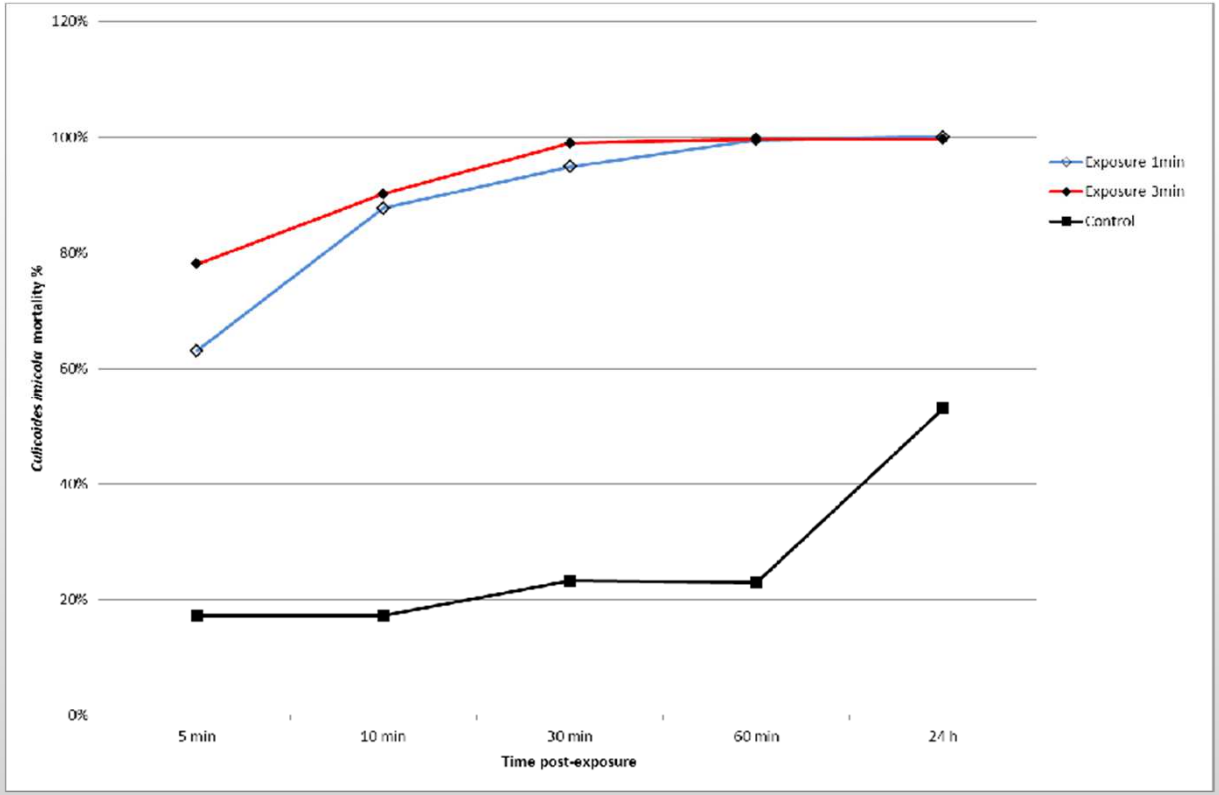
Stabling with alphacypermethrin-treated HDPE mesh

- High density polyethylene (HDPE)
  - Woven, 0.3 mm mesh, 70% shade
  - Mesh dipped (30 min) in 0.28 mg/ml alphacypermethrin (31.8–33.7 mg/m^2)
- Contact bioassay *C. imicola* exposure to mesh for 1 or 3 minutes
- Mesh applied to jet stall housing horses
  - Direct aspiration of midges at sunset
- Effect of mesh on horse safety
  - Climate, clinical variables (TPR), faecal glucocorticoid stress indicators



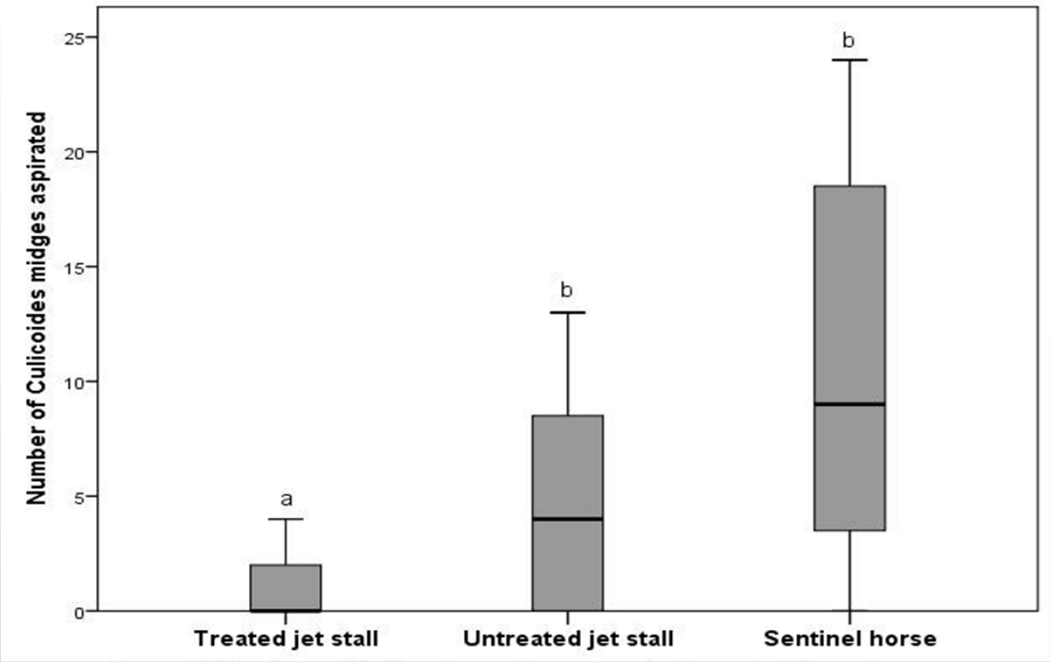
Stabling with alphacypermethrin-treated HDPE mesh

- Alphacypermethrin-treated HDPE mesh had a rapid insecticidal effect against field-collected *C. imicola*



Stabling with alphacypermethrin-treated HDPE mesh

- The mesh reduced the *Culicoides* midge attack rate in the treated stall compared to the untreated stall and a sentinel horse by 6 times and 14 times, respectively
- No negative impact on horse clinical variables or stress indicators



Stabling with cypermethrin/ pyrethrin treated PVC-coated polyester

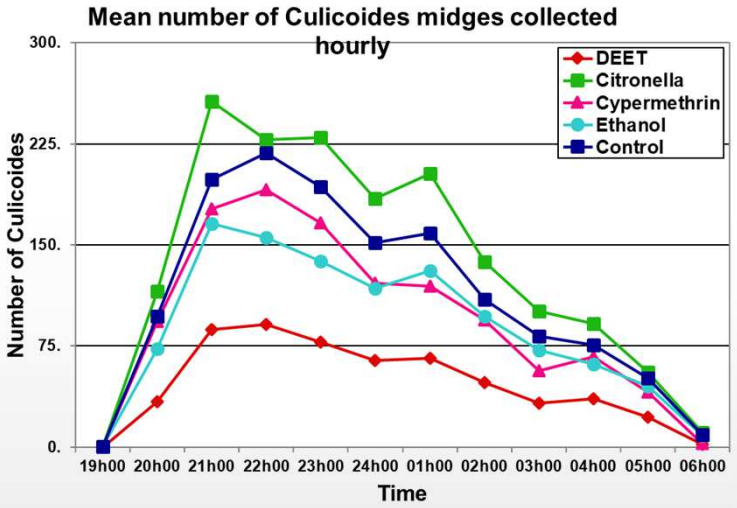
- PVC-coated polyester mesh (1.6 mm aperture)
- Sprayed with 0.15% cypermethrin, 0.2% pyrethrins in UK (Baker et al. 2015)
- Modified WHO cone bioassay
- Mesh applied to boxes housing light traps
- Mesh applied to stables housing horses
  - Light traps operated inside stable
- Bioassay showed 100% mortality at days 1, 7, and 14 days
- Mesh significantly reduced number of midges entering the stable - mean CPI 96% compared to no mesh control

Insecticides

- Insecticide susceptibility tests on midges from France, Spain, Senegal, South Africa (Venail et al. 2015)
  - Toxicity Deltamethrin > cypermethrin > permethrin
- Deltamethrin
  - Variable results between bioassays and field studies in treated cattle and sheep
  - 1% deltamethrin pour on applied to horses in UK - assessment with light trap and poor results (Robin et al. 2015)
- Cypermethrin
  - Overall, good results in field studies on treated cattle and sheep
  - High mortality rates in midges exposed to hair from treated cattle, sheep and horses (0.1%) cypermethrin (Papadopoulos et al. 2009, 2010)
  - High mortality rate in midges exposed to mesh treated with cypermethrin (Baker et al. 2015; Page et al. 2014)
- Permethrin
  - Variable results between bioassays and field studies in treated cattle and sheep
  - 4% pour on resulted in 86% improvement in 'sweet itch' in horses (Stevens et al. 1988)
  - 0.6% pour on applied to horses in tent traps - no significant effect (De Raat et al. 2008)
  - 0.9% Permethrin and 2% DEET spray applied to horse - no significant effect on light trap catches (Lincoln et al. 2015)
- Organosphosphates
  - Not recommended because of lower efficacy and human/ host/ environment safety concerns

Insect repellents

- N,N-diethyl-3-methylbenzamide (DEET)
  - "Gold standard" repellent in human studies
  - Good results for up to 10 hours with 15% DEET applied to polyester/ HDPE mesh in light trap studies (Braverman et al. 1999, 2000; Page et al. 2009)
  - No significant effect of 2% DEET plus 0.9% permethrin spray applied to horses, assessed with light trap only (Lincoln et al. 2015)
- Avoid high concentrations over 15% DEET
  - Excessive oiliness of hair coat with repeated application; ulceration with 50% and 75% (Palmer, 1969)
  - No adverse effects when 15-17% DEET applied to horses for assessment of tabanid fly control in Switzerland (Herholz et al. 2016)



Insect repellents

- Lemon eucalyptus oil/ p-menthane-3,8-diol (PMD)/ Citriodiol
  - Extracted from *Corymbia citriodora* (= *Eucalyptus citriodora*)
  - 50% PMD good repellency on mesh in light trap studies (Braverman et al. 2000)
  - Antifeedant effect (Baker et al. 2015)
- Citronella oil
  - = Lemon grass oil extracted from Cymbopogon
  - Poor repellency on mesh in 2 light trap studies (Page 2009, Venter 2014)
- Combination of 2% lemon grass oil plus 16% PMD
  - Human landing assay - repellency >95% to 5 hours (Santamaria 2012)
- Neem oil
  - Anti-landing and antifeedant effect (Blackwell 2004)
  - Limited repellent effect in olfactometer assay (Gonzalez 2014)
  - Poor field efficacy when applied to sheep/ smoke in India - light trap study (Keyser et al. 2017)
- Kerosene/ liquid paraffin
  - No scientific evidence for efficacy
  - Negative safety aspects – hair loss, fire risk

Horse and environment safety considerations

- Adequate ventilation of mesh-protected stables essential to avoid compromised thermoregulation and respiratory disease
  - Horses thermoregulate through sweating
  - In high-temperature/ humidity climate use of indoor fans recommended
- Beware of insecticide adverse effects on non-target species (Del Rio et al. 2014)
  - Apply targeted use only
  - Avoid indiscriminate insecticide use outside stables

Thank you for your attention

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