Pyrethroid Insecticides: Do They Cause Infertility in Cattle?

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Background

- Pyrethroid insecticides used in beef cattle operations to combat pests (flies, ticks, lice)
- Methods of application include
  - Topical (pour ons) & ear tags
  - Back rubbers
  - Sprays

Seasons for pest control coincide with breeding seasons in most beef operations
Background

- Pyrethroids are metabolized by same group of enzymes that clear steroid hormones

http://www.emc.maricopa.edu/faculty/farabee/biobk/biobookendocr.html
Background

• Pyrethroids bind to hormone receptors

Adapted from: http://www.emc.maricopa.edu/faculty/farabee/biobk/biobookendocr.html
Background

- Toxicological studies have shown a negative effect on steroid hormone production in some species
- Many studies reported with animals utilized large oral daily dosages
Background

- Recently popular press articles have implicated pyrethroid insecticides for depressing sperm motility in bulls.
- No controlled experimental evidence reported for effects of pyrethroid labeled for cattle application on reproductive performance in the whole animal.
Project Objective

To assess the effects of commercially available pyrethroid insecticides (applied at label dosages and routes of administration) on bull semen quality and pregnancy rates in cows.
Bull Study Design

28 Bulls

- Control
- Pour On
- Fly Tag
- Pour On + Fly Tag

Weekly Assessment

- Motility
- Morphology
- Testosterone
Insecticide Ear Tags

- Beta-cyfluthrin 8%
- Piperonyl butoxide 20%
- 2 tags per animal
Pour-On

CyLence®
Pour-On Insecticide

For Control of Horn Flies, Face Flies, Biting Lice and Sucking Lice on Beef and Dairy Cattle (Including Lactating)

Active Ingredient: Cyfluthrin; cyano (3-chloro-3-phenoxypyphenyl) methyl-3-(2,2-dichloethenyl)-2,2-dimethyl-cyclopropane carboxylate 1%

Other Ingredients 99%

Total 100%

KEEP OUT OF REACH OF CHILDREN
WARNING
See Rear Panel for First Aid and Other Precautionary Statements

6 Pints (2.8 L)

Cyfluthrin (1 %)
Dosage (24 ml/animal; topical)
Pretreatment

- Weighed
- BCS (1-9)
- Reproductive examination
  - Scrotal circumference
  - Rectal palpation
- Semen Collection
  - Electroejaculation
    - Motility
    - Morphology
- Serum Sample
Weekly samples

- Weight
- Reproductive examination
- Electroejaculation
  - Semen
- Serum samples
Semen quality assessment

- Phase contrast microscopy with CASA (computer assisted sperm analyses)
- SpermVision (Minitube, Inc)
Motility Assessment

- Overall
- Progressive

- Removes subjectivity
Morphology

- Identify individual sperm
  - Normal
  - Abnormal
    - Classify
Hormone Assays

- Serum samples
- Centrifuge semen samples
  - Supernatant
  - Test for levels of testosterone

Day 1

Day 62
Statistical Analysis

- Statistical analysis
  - Repeated measure analysis
    - MIXED SAS Procedure
Results

- 4 bulls were removed from the study
  - Lameness
  - Systemic illness
- 2 control group, 2 pour group
Results: Motility

P=0.41
Results: Motility

Overall Motility Average per Treatment Group

- Control
- Pour-on
- Fly Tags
- Pour-on + Fly Tags

Day 0 | Day 7 | Day 14
--- | --- | ---
60 | 70 | 65
70 | 80 | 75
80 | 90 | 85
90 | 100 | 95

Motility Percent
Results: Motility

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Pour-On</th>
<th>Fly Tags</th>
<th>Pour-On + Fly Tags</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Treatment</td>
<td>80.6</td>
<td>76.82</td>
<td>77.24</td>
<td>79.79</td>
</tr>
<tr>
<td>Week 3 Post Treatment</td>
<td>91.87</td>
<td>82.74</td>
<td>88.16</td>
<td>85.56</td>
</tr>
<tr>
<td>Week 6 Post Treatment</td>
<td>90.65</td>
<td>75.06</td>
<td>82.9</td>
<td>87.44</td>
</tr>
<tr>
<td>Week 9 Post Treatment</td>
<td>90.87</td>
<td>82.94</td>
<td>84.11</td>
<td>88.68</td>
</tr>
</tbody>
</table>
Results: Morphology

P=0.41
Results: Morphology

![Graph showing normal morphology after spermatogenic cycle with data points for Pretreatment and Day 63 for Control, Pour-On, Fly Tags, and Pour-on + Fly Tags.]
Results: Morphology
Results: Testosterone

• Serum
• Seminal Plasma

Testosterone in Treatment Bulls

Day 0

Day 62

P=0.16

Day 1

Day 62
Cow Study Design

- CO-Synch + CIDR and timed AI
  - Insecticide @ CIDR insertion

123 Cows

Random Assignment

Control

Pour On + Fly Tag
Cow Study Design

123 Cows

Control

Pour On + Fly Tag

Day 10 Progesterone

Day 17 Progesterone

AI Conception Rates
Progestosterone Analysis

Pyrethroid Treatment

Day 10

Day 17
Statistical Analysis

- Statistical analysis
  - Progesterone data
    - MIXED SAS Procedure
  - AI Pregnancy Rate
    - GENMOD SAS Procedure
Results: Progesterone

*P=0.03

*Post AI

Day 10*

Day 17

Control

Treatment

P=0.94

*P=0.03
Day 10 Progesterone Effects

<table>
<thead>
<tr>
<th></th>
<th>Treatment Group Progesterone</th>
<th>Control Group Progesterone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 10</td>
<td>5.5</td>
<td>6.4</td>
</tr>
<tr>
<td>Day 17</td>
<td>6.4</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Results: AI Pregnancy Rate

P=0.65
Conclusion

- **Cyfluthrin** pyrethroid insecticide (at label dosage and route of administration) do not cause harmful effects on cattle fertility
Conflicting Results?!?

• Synthetic Pyrethroid?
  – deltamethrin > cyfluthrin > fenvalerate  
    >cyhalothrin > cypermethrin > permethrin > 3-PBA (Du et al. 2010)

• Dosage?
  – Percent of pyrethroid
  – Duration of tx

• Route of Administration?
  – Oral (accidental exposure?)
Which insecticide is safe?

Ear Tags

Only tested **Cyfluthrin** at 8%
Which insecticide is safe?

<table>
<thead>
<tr>
<th>Pour-on Insecticides for Pasture Flies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atroban, Back Side, Back Side Plus, Boss, Brute, Buzz Off, DeLice, Durasect II, Expar, Permethrin CD, Permethrin CDS, Ultra Boss (permethrin)</td>
</tr>
<tr>
<td>Clean-up (5% diflubenzurin + 5% permethrin)</td>
</tr>
<tr>
<td><strong>CyLence 1% (cyfluthrin)</strong></td>
</tr>
<tr>
<td>Ivomec 0.5% (ivermectin)</td>
</tr>
<tr>
<td>Lysoff 7.6% PO (fenthion)</td>
</tr>
<tr>
<td>StandGuard Pour-on Insecticide 0.5% (g-cyhalothrin)</td>
</tr>
<tr>
<td>Ultra Sabre Pour-on Insecticide 1% (l-cyhalothrin)</td>
</tr>
</tbody>
</table>
Future Studies

• Different routes of administration (on label)
  – Spray
  – Back rubs
• Different types of pyrethroid
• Different dosage of pyrethroid
Take Home Message…

• Read and follow label instructions
  - Reapply only when label allows

• Do not contaminate feed or water
  - Animal spray products have warning label
Acknowledgements

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    • Frank Ireland, MS
    • Tim DelValle
    • Ashley Loup
QUESTIONS?

• References
  – Yousef, Mokhtar I. "Vitamin E Modulates Reproductive Toxicity of Pyrethroid Lambda-cyhalothrin in Male Rabbits." Food and Chemical Toxicology 48.5 (2010): 1152-159.