Kaolin as inert material in bio-pesticide formulations supplements the hazard to useful insects

Reet Karise
Riin Muljar
Marika Mänd
Pesticide studies

• Field exp
• Semi-field exp
• Mortality tests
• Behavioural exp
  • Learning
  • Choice
  • PER
  • ...
• Physiological exp
  – Dissection
  – In-vivo?
Respiration

• Reflects the metabolic rate of the organism
• Easily vulnerable system
MR and respiratory patterns

Continuous (Cont.)
Cyclic (CGE)
Discontinuous (DGE)
• Flow through respirometry: LI-7000 CO₂/H₂O analyzer combined with IR-actography
  – Metabolic rate
  – Respiratory rhythms
  – Water loss rate
Neurotoxic effect

Dipping in water solution of Fastac 50EC for 10 sec

0.004%: obtained 0.099 μg/bee
0.002%: obtained 0.087 μg/bee

LD50 = 0.059 mg/bee

Contact action: alpha-cypermethrin

DGE => Continuous

0.004%

DGE => CGE

0.002%

The treatment

Median
25%-75%
Non-Outlier Range
Extremes

a
b

Longevity of bumble bees (days)

0.004% 0.002% Dist. water

The treatment

0 4 8 12 16 20 24 28

VCO₂ (ml h⁻¹)

Time (hours)

0 1 2 3 4 5 6

0 1 2 3 4 5 6

0 1 2 3 4 5 6

0 1 2 3 4 5 6
Entomovector technology

• New method
• Uses powdery biopreparations
• Decreases the amounts of preparations needed
• Must be safe
  – Plant products
  – Vectoring insect
  – Insect products (honey)
Kaolin

• Kaolin powder
  – Used against stored product pests
  – Causing respiratory failure?
  – Changing cuticule properties?

• Kaolin particle film
  – Physical barrier/deterrent
  – Visually or tactically unrecognizable as a host

• Kaolin is frequently used as inert materials in bio-preparations
Our experiment

Are kaolin and powdery formulations affecting bumble bee physiology?

• Bumble bees: Koppert Biological Systems
• Treatments:
  – Kaolin
  – Prestop Mix (*Gliocladium catenulatum*)
  – BotaniGard (*Beauveria bassiana*)
  – Wheat flour
  – Blank treatment for control
Single treatment, immediate effect (N = 6; 18 °C)
- Immediate effect on metabolic rate and water loss rate (measured 3 h before and 3 h after the treatment)
- Effect on cuticular and respiratory WL

Single treatment, long term effect
- Effect on mortality (N = 20; 18 °C and 28 °C)
Results

- MR normally decreases during long observation
- Powders have capacity to prevent calming process
- Normally water loss is not changing or changing a few
- Kaolin and Prestop Mix caused significant increase in WL rate
Respiratory and Cuticular WL

- Can be measured during the periods of DGE
- We calculated mean respiratory and cuticular WL of 3 consecutive cycles of DGE

\[
\text{Respiratory WL} = \text{Total WL} - \text{Cuticular WL}
\]
- No difference in the mean Total WLR during DGE
- No difference in mean Respiratory WL
- Significant differences in cuticular WL
  – Kaolin and Prestop Mix
The longevity

- Median longevity shorter at 18 °C
  *** BotaniGard
- Maximum longevity shorter at 28 °C
- At 18 °C only BotaniGard differed significantly
- At 28 °C BotaniGard and kaolin differed significantly
Conclusions

• Kaolin increases permeability of insect cuticle to water vapour
• This may affect the survival of individuals
• The testing inert materials is not obligatory
• Yet these might pose risks to pollinators or vectoring insects
• Physiological methods, for instance respirometry, can be one way to discover sub-lethal effects of pesticides or other stressors