Effects of spinosad on Honey bees (*Apis mellifera*): Findings from over ten years of testing and commercial use

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Talk outline

1. Introduction to spinosad
2. Re-analysis of semi-field data
3. New tunnel tests
4. Meeting future protection goals and risk assessment needs
5. Risk mitigation
6. Current status in the EU
7. Feedback from around the world
1. Introduction to spinosad

- Fermentation product of the Actinomycete bacterium *Saccharopolyspora spinosa*
- The active ingredient is a mixture of spinosyn A and spinosyn D
Spinosad is registered globally

- Trademarks: Tracer, Success, SpinTor, Entrust
- First registration: 1998 (US cotton)
- Registered: over 150 crops in N. America, Latin America, Asia, Europe, Australasia
- Approved uses: vegetables, fruit trees, turf, viticulture and ornamentals
- Targets: lepidopteran larvae, thysanoptera and some diptera, coleoptera and hymenoptera
Lots of data

Lab testing

Brood assessments

Semi-field / tunnels tests

Field testing
Lots of data (regulatory and supplemental)

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<td><strong>Total (all)</strong></td>
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Spinosad is intrinsically toxic to honey bees

- It is an insecticide!
  - Acute oral toxicity (worker adults):
    - $LD_{50} 0.057 \mu g/bee$ (spinosad)
    - $LD_{50} 0.049 \mu g as/bee$ (NAF-85)
  - Acute contact toxicity (worker adults):
    - $LD_{50} 0.0036 \mu g/bee$ (spinosad)
    - $LD_{50} 0.050 \mu g as/bee$ (NAF-85)
- Tier I Hazard quotients in excess of the trigger of 50
- Higher tier (semi-field tests conducted)

Source: SANCO/1428/2001 – rev. final
14 July 2006
2. Re-analysis of semi-field data

- An analysis of higher tier studies with regard to mortality can help to characterize and address uncertainties on this parameter.

- 10 trials performed in France, UK and Germany.

- Semi-field design (tunnel + cages) conducted according to CEB method n°129 and EPPO guideline 170 (EPPO 1992).

- Application rate ranging from 10 to 540 g ai/ha, depending on the pest, sprayed onto flowering crops.

- Crops selected to maximize foraging and thus exposure: phacelia, oilseed rape, wheat and sugar solution.

- Focus on the 96 g a.s./ha rate of spinosad.
Semi-field tests: Combination of crops, application rate and exposure conditions

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<tr>
<th>Year</th>
<th>Site Type</th>
<th>Country</th>
<th>Crop (Common)</th>
<th>Application type</th>
<th>Dose ai (g ai/ha)</th>
<th>nb of bees/hive</th>
<th>repetitions</th>
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*Wheat was sprayed daily with sugar solution to simulate honeydew production*
Data analysis: semi-field studies

- Use of a mortality index: $I_{tox}$ (CEB method)

\[
I_{tox} = \frac{M_a}{M_b} \times \frac{C_b}{C_a}
\]

$M_a$: mortality in test substance after treatment
$M_b$: mortality in test substance before treatment
$C_a$: mortality in control after treatment
$C_b$: mortality in control before treatment

- Analysis of $I_{tox}$ over time, per day and up to one week after treatment
- Influence of the time of application on the level of effects:
  - When bees are present
  - When bees are not present: early in the morning or late in the evening
- Comparison with a control (water) and a toxic reference (dimethoate)
Mortality: influence of application rate

Impact of the dose 1DAT

During foraging
- 10.08 g ai/ha: 1.25 (1 data)
- 19.68 g ai/ha: 3.03 (1 data)
- 50 g ai/ha: 2.30 (1 data)
- 76 g ai/ha: 3.12 (3 data)
- 96 g ai/ha: 4.01 (11 data)
- 144 g ai/ha: 6.26 (4 data)

Out of foraging
- 76 g ai/ha out of foraging: 1.10 (9 data)
- 96 g ai/ha out of foraging: 1.89 (11 data)
- 144 g ai/ha out of foraging: 1.37 (3 data)
- 540 g ai/ha out of foraging: 2.41 (1 data)

Median and Mean

Dow AgroSciences
Daily mortality: 96 g ai/ha applications during bee activity
Daily mortality: 96 g ai/ha applications outside of bee activity
Spinosad: Conclusions for lethal effects at 96 g a.s./ha

- Applications during bee activity:
  - May cause a short term increase in mortality compared to the control
  - Approx. 3 – 6x higher 1 day after application
  - From day 2 to 1 week mortality levels similar to control

- Applications out of bee activity:
  - Low impact the following day when bee forage on fresh dry product residues
  - Mortality levels similar to control throughout the study
Keeping the data set in line with risk assessment

- First data generated some years ago, in line with guidance documents (EPPO, 2002 and SANCO 10329/2002)
- Since the system has gained experience in evaluating the risks, with evolution in the interpretation of studies
- Revised EPPO documents (2010)
- EC Regulation 1107/2009 and new terminology
- New data requirements to come, and
- Learning from 10 years of use in many countries…

…is spinosad still a good solution?
3. New tunnel tests

- Aim: confirm effects of spinosad applied at 76 and 96 g a.s./ha
  - Applied during bee activity (1 test)
  - Applied out of bee activity (3 tests)
- Assessments
  - Mortality (3 tests)
  - Foraging (3 tests)
  - Impact on brood (OECD 75 methodology) (2 tests)
  - Behavioural abnormalities (3 tests)
  - Colony strength up to 28 days (2 tests)
  - Colony strength up to 60 days (1 test)

- Example data from the 3 tests
Mortality: Spinosad applied out of bee flight

**Mean number of dead bees ± SD [n]**

- **GF-976 76 g a.i./ha**
- **GF-976 96 g a.i./ha**
- **Insegar [fenoxycarb]**
- **Perfekthion EC [dimethoate]**

Days of experiment:
- Day 0
- +1
- +2
- +3
- +4
- +5
- +6
- +7
Foraging: Spinosad applied out of bee flight

- Water
- GF-976 [76 g a.i./ha]
- Reference Item Insegar GF-976 [96 g a.i./ha]
- Reference Item Perfekthion EC

Mean numbers of bees/m² ± SD [n]

Days of experiment:
- Day 0
- Day 1
- Days 2 to 7

Mean numbers of bees/m² (± SD) for different days of the experiment.
Impact on brood:
Spinosad applied out of bee flight

Brood compensation index

Day post brood fixing date

- Water
- GF-976 76 g a.i./ha
- GF-976 96 g a.i./ha
- Reference item Insegar
- Reference item Perfektion

Day post brood fixing date:
- BFD +6
- BFD +10
- BFD +15
- BFD +21

References:
- Insegar
- Perfektion

Symbols:
- *

Source: Dow AgroSciences
Colony strength up to 60 days

Mean no. Bees/colony

Day of study (post exposure)

- Water
- GF-976 76 g a.i./ha (after)
- GF-976 96 g a.i./ha (after)
- GF-976 76 g a.i./ha
- GF-976 96 g a.i./ha
- Reference item Perfektion
Conclusions

Spinosad at 76 and 96 g a.s./ha

- Applied out of bee flight
  - Caused no unacceptable effects on:
    - Mortality
    - Foraging
    - Brood development or survival
    - Behavioural abnormalities
    - Colony strength 28 to 60 days after exposure

- Applied during bee flight
  - Caused only minor short lived effects on acute mortality
4. Meeting future protection goals and risk assessment needs

Regulation EC 1107/2009

3.8.3. An active substance, safener or synergist shall be approved only if it is established following an appropriate risk assessment on the basis of Community or internationally agreed test guidelines, that the use under the proposed conditions of use of plant protection products containing this active substance, safener or synergist:
— will result in a negligible exposure of honeybees, or
— has no unacceptable acute or chronic effects on colony survival and development, taking into account effects on honeybee larvae and honeybee behaviour.

Possible for spinosad if applications are made to crops not flowering/unattractive to bees or to flowering crops only when bees are not active
Risk assessment

- Tier I HQ indicated a potential high risk
  - **Mitigation/management:** E.g. Do not apply to flowering crops

- Semi-field tests:
  - Direct overspray may cause adverse effects
    - **Mitigation/management:** E.g. Dangerous to bees avoid their exposure
  - Out of bee flight applications did not pose an unacceptable risk
    - **Mitigation/management:** E.g. Applications during flowering allowed outside the presence of bees
5. Risk mitigation

Corresponding label statement for those products having been evaluated on purpose, could be:

- “When applications are to be made to crops in bloom these should be made at times which avoid the direct exposure of honey bees i.e. Applications after sunset and before bees start to forage the following day”
6. Feed back from EU countries (1)

Belgium:
- For outdoor uses, the label indicates “Do not use on flowering crops or in the neighbourhood of flowering weeds”
- For indoor uses: it mentions “Cover bee and bumblebee boxes when spraying during flowering. Uncover when all spray liquid has dried. Introduce bumblebees not earlier than 4 days after spraying.”

Netherlands:
- For outdoor uses: “Do not use on flowering crops or non-flowering crops that are actively visited by bees and bumblebees.”
- For indoor uses: “Cover or remove bee and bumblebee boxes during flowering when spraying and during the following day. Visually check whether all spray liquid has dried. Prevent bees and other pollinator insects to enter the greenhouse by covering all entries with insect nets.”
- One incident occurred in a glasshouse when residues were not dried, no other accident related to spinosad.
6. Feed back from EU countries (2)

France:

- **Order of 23 November 2004:** “In order to protect bees and other pollinators, the spraying of insecticides and acaricides is forbidden during flowering or during periods of exudates production.”

- For spinosad, the dossier was evaluated for uses on crops with a protracted flowering period, to explore the possibilities to control pests occurring close to the flowering period. Acceptable risks to the colonies tested had to be established. **Outcome:**
  - For outdoor uses on solanaceous crops, treatment is allowed 7 days before and 7 days after the flowering peak;
  - For indoor uses on solanaceous crops and strawberries, a 12 hour interval between application and re-introduction of pollinators is necessary.
6. Feed back from EU countries (3)

France:

- **Regulation (EC) No 404/2008** as concerns the authorisation of spinosad on organic production of agricultural products, implemented in France

- (4) “Spinosad is a new insecticide from microbial origin that is found to be essential for the control of some key-pests and contributes to the sustainability of the production system for other crop-pest situations.

- However, when using it, the risk to non-target organisms should be minimised.”

- No incident reported with spinosad.
6. Feedback from EU countries (4)

Germany:
- Classified as “B1”, “no use at flowering growth stage”

UK:
- Only applications outside of flowering are approved
- Spinosad has never been mentioned in Wildlife Incident Investigation Scheme (WIIS)

7. Feedback from around the world (1)

USA (e.g. California):

- Authorized on many crops including citrus and almond trees
- Application according to the bee law (2 hours after sunset and 1 hour before sunrise) for crops in flower
- Drying period of 3 hours recommended on other labelling, as well as no application “to blooming, pollen shedding or nectar producing plants if bees may forage during this period”
- No related incidents reported

South Africa:

- Warning on the label indicating that applications should be avoided when bees are active i.e. “Apply only at night when crop is flowering or other foraging vegetation is within 500 m from the spraying area”
- No related incidents reported
7. Feedback from around the world (2)

Australia:
- Mandatory label for “Protection of Livestock” with the precaution to not spray onto bees or beehives and the mention that “once the spray deposit has dried, foraging bees will not be affected”.

New Zealand:
- Similar statement + the following label warning: “POLLINATORS: When applied during non-foraging periods Success Naturalyte Insect Control will not interfere with the activity of honey bees once the spray has dried. At least 3 hours drying time should occur before bee foraging is expected. At times when bees aggregate in large numbers outside the hive, ensure they are not directly contacted by the spray.”
- No incident reported in either country
Summary

- Spinosad is an insecticidal active substance
- Intrinsically toxic to bees
- Thoroughly researched
- Registered globally

- Initial risk assessment indicated a potential risk
- Higher tier semi-field studies indicated that the product can and has been used safely with appropriate risk mitigation/management

- Spinosad may be used to control pests occurring at flowering without impact on pollinators, provided precautions are taken to avoid spray on pollinators
Thank you for your attention