IRAC

Insecticide Resistance Action Committee

Insektizidresistenz: Vergangenheit, Gegenwart und Zukunft

Dr. Ralf Nauen
IRAC Chairman

Fachveranstaltung: Pflanzenschutz im Ackerbau
LfULG im Triebischtal, Dez 13, 2012

Was ist Resistenz?

„Resistenz von Schadinsekten und -milben stellt eine genetisch bedingte Veränderung, als Reaktion auf eine Selektion durch ein Pflanzenschutzmittel dar, die zur wiederholten Beeinträchtigung der Kontrolle bei empfohlenen Aufwandmengen führen kann.“

Insecticide Resistance Action Committee (IRAC)

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Vor mehr als 100 Jahren eine entscheidende Frage…

Melander AL (1914)

Can insects become resistant to sprays?

Journal of Economic Entomology **7**, 167

Der erste dokumentierte Resistenzfall datiert aus dem Jahr 1908 (Schwefelkalk Minderwirkung an Quadraspidiotus perniciosus)

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…und heute, eine der größten Herausforderungen in der modernen Landwirtschaft und damit existenziell

Seit 1914 wurden bis 2011

Melander (1914) JEE 7, 167

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Weltweit rasante Zunahme resistenter Arten!

553
(2011)

Modifiziert nach Daten von:
Geoughiou and Mellon 1983, Georghiou 1990, Mota-Sanchez et al. 2002, Whalon et al. 2008

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Wer oder was ist IRAC?

- **Insecticide Resistance Action Committee (IRAC)**
  - Hervorgegangen aus der “Pyrethroid Efficacy Group” (PEG), die sich der weltweit zunehmenden Pyrethroidresistenz widmete
  - Gegründet 1984 wegen der zunehmenden Entwicklung von Insektizidresistenzen, vor allem auch gegen neue Wirkstoffklassen – und damit im 28. Jahr aktiv
  - Technische Expertengruppe der Agrarindustrie spezialisiert auf Fragen der Insektizidresistenz (global)
  - Formale Integration in die Weltorganisation der Pflanzenschutzindustrie, CropLife International, im Jahr 2010
  - Zweck ist die Abstimmung und Koordination von globalen Resistenzmanagement-Aktivitäten um nachhaltige Landwirtschaft und öffentliche Gesundheit zu unterstützen

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IRAC INTERNATIONAL

Firmen

- Bayer CropScience
- BASF The Chemical Company
- BELCHIM Crop Protection
- CHEMINOVA
- Dow AgroSciences
- DuPont
- FMC
- Makhteshim Agan
- Monsanto imagine
- Nihon Nohyaku Co.,Ltd.
- Nufarm
- Sumitomo Chemical
- Syngenta
- Vestergaard Frandsen Disease Control Textiles

EXECUTIVE Committee (Vorstand)

- Crop Protection
- Public Health
- Plant Biotechnology

14 Firmen

11 Internationale Arbeitsgruppen

Arbeits-gruppen

- Steering Group
- Public Health
- Biotechnology
- Methods
- Mode of Action
- Comm./Education
- R. Database (MSU)
- Coleoptera
- Sucking Pest
- Lepidotpera
- Diamide

Länder- und Regionengruppen

- IRAC Spain
- IRAC US
- IRAC S.E. Asia
- IRAC Australia
- IRAC Brazil
- IRAC India
- IRAC S. Africa

CropLife International

Die Anzahl der Teilnehmer wuchs mit den Jahren: 1991 vs 2011

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Die Internetseite von IRAC – www.irac-online.org

- **IRAC's Kommunikationsplatform Nr.1**
  - IRAC Newsletter
  - Anleitungen
  - Poster
  - Broschüren
  - Videos
  - Methoden
  - MoA Klassifizierung

Mode of Action Classification

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Insecticide Resistance Action Committee

The Key to Resistance Management

More information on IRAC and the Mode of Action Classification is available from:
www.irac-online.org or enquiries@irac-online.org

Group 1: Acetylcholinesterase (AChE) inhibitors (Only major representatives of this group are shown)

1A Carbamates

1B Organophosphates

Group 2: GABA-gated chloride channel antagonists

2A Cyclodiene Organochlorines

2B Phenylpyrazoles (Fiproles)

Group 3: Sodium channel modulators (Only major representatives of group 3A are shown)

3A Pyrethroids Pyrethrins

3B DDT, Methoxychlor

Group 4: Nicotinic acetylcholine receptor (nAChR) agonists

4A Neonicotinoids

4B Nicotine

Group 5: Nicotinic acetylcholine receptor (nAChR) allosteric modulators

5 Spinosyns

Group 6: Chloride channel activators

6 Avermectins, Milbemycins

Group 7: Juvenile hormone mimics

7A Juvenile hormone analogues

7B Fenoxycarb

7C Pyriproxyfen

Group 8: Miscellaneous non-specific (multi-site) inhibitors

8A Alkyl halides

8B Chloropicrin

8C Sulfuryl fluoride

8D Borax

8E Tartar emetic

Group 9: Selective homopteran feeding blockers

9B Pymetrozine

9C Flonicamid

Group 10: Mite growth inhibitors

10A Clofentezine 10A Hexythiazox

10B Etoxazole

Group 11: Microbial disruptors of insect midgut membranes and derived toxins

Group 12: Inhibitors of mitochondrial ATP synthase

12A Diafenthiuron

12B Organotin miticides

12C Propargite

12D Tetradifon

Group 13: Uncouplers of oxidative phosphorylation via disruption of proton gradient

13 Pyrroles, Dinitrophenols

Group 14: Nicotinic acetylcholine receptor (nAChR) channel blockers

14 Nereistoxin analogues

Group 15: Inhibitors of chitin biosynthesis, type 0

15 Benzoylureas

Group 16: Inhibitors of chitin biosynthesis, type 1

16 Buprofezin

Group 17: Moulting disruptor, Diptera

17 Cryomazine

Group 18: Ecdysone receptor agonists

18 Diacylhydrazines

Group 19: Octopamine receptor agonists

19 Amitraz

Group 20: Mitochondrial complex III electron transport inhibitors

20A 20B 20C

Group 21: Mitochondrial complex I electron transport inhibitors

21A METI acaricides and insecticides

21B Rotenone

Group 22: Voltage-dependent sodium channel blockers

22A Indoxacarb

22B Metaflumizone

Group 23: Inhibitors of acetyl CoA carboxylase

23 Tetronic & Tetramic acid derivatives

Group 24: Mitochondrial complex IV electron transport inhibitors

24A Phosphine

24B Cyanide

Group 25: Mitochondrial complex II electron transport inhibitors

25 Cyenopyrafen

Group 28: Ryanodine receptor modulators

28 Diamides

Group UN: Compounds of unknown or uncertain mode of action

Guidance on the use of Sub-Groups:

- Represent distinct structural classes believed to have the same mode of action
- Provides differentiation between compounds that may bind at the same target site
- Are structurally different such that risk of metabolic cross-resistance is lower than for close chemical analogs
- Are likely to be metabolized by different enzymes - may bind differently enough within the target site that the chance of selection for metabolic/target-site resistance is reduced compared to close analogs.

- In the absence of other alternatives, it may be possible to rotate compounds between sub-groups if it is clear that cross resistance mechanisms do not exist in the target populations
- Not all of the current groupings are based on knowledge of a shared target protein. For further information please refer to the IRAC Mode of Action Classification document.
- 1A & 1B - If there are no other alternatives, compounds may be rotated in situations where cross-resistance mechanisms are known to be absent in the insect populations to be treated.

- 3A & 3B - If there are no other alternatives, compounds may be rotated in situations where cross-resistance mechanisms (e.g. kdr) are known to be absent in the insect populations to be treated. DDT is no longer used in agriculture and therefore this is only applicable for the control of human disease vectors such as mosquitoes, because of a lack of alternatives.
- 10A - Clofentezine & Hexythiazox are grouped because they commonly exhibit cross-resistance even though they are structurally distinct, and the target site for neither compound is known.
- 22A & 22B - Although these compounds are believed to have the same target site, they have been sub-grouped because they are chemically distinct, and current evidence indicates that the risk of metabolic cross-resistance is low.

Structures are reproduced from the Pesticide Manual with permission from the British Crop Protection Council

The poster is for educational purposes only. Details presented are accurate to the best of our knowledge at the time of publication but IRAC or its member companies cannot accept responsibility for how this information is used or interpreted

Poster Version 2.0, July 2006. Based on the Mode of Action Classification - Version 6.3

Erhältlich in vielen Sprachen (Japanische Version)

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Resistenzmanagement ist in Europa eine zulassungs-relevante Forderung und Bestandteil der EC 1107/2009

REGULATIONS

REGULATION (EC) No 1107/2009 OF THE EUROPEAN PAI

of 21 October 2009

concerning the placing of plant protection products on the ma
79/117/EEC and 91/414/EE

Article 18

Work programme

The Commission may establish a work programme grouping together similar active substances setting priorities on the basis of safety concerns for human and animal health or the environment and taking into account, as far as possible, the need for an effective control and resistance management of target pest. The programme may require interested parties to submit all the necessary data to the Member States, the Commission and the Authority within a period provided for in the programme.

European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

Efficacy evaluation of plant protection products

Resistance risk analysis

Specific scope

This standard describes how the risk of resistance to plant protection products can be assessed and, if appropriate, systems for risk management can be proposed, in the context of official registration of plant protection products.

Specific approval and amendment

First approved in 1999-09.
Revision approved in 2002-09.

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Resistenzmanagement

- **Resistenzmanagement ist**

  - ein Instrument der Nachhaltigkeit im
  - Schutz vor Schädlingen und Pflanzenkrankheiten,
  - und damit zur Sicherung der Erträge sowie der Qualität

  - vom Gesetzgeber vorgeschrieben
  - und damit keine Wirtschaftlichkeitsoption der Industrie zur Positionierung möglichst vieler Wirkstoffe

  - auf unbestimmte Zeit, die einzige Möglichkeit Wirkstoffe nachhaltig zu schützen und einzusetzen, da es immer schwieriger wird neue Wirkmechanismen zu finden

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Resistenz ist ein globales Problem

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Ein etwas anderer Feldversuch

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Cimex lectularius (Bettwanze)

- Werden immer wichtiger
- Blutmahlzeiten während der Nacht
- Entwickelten Pyrethroidresistenz
- Bei empfindlichen Menschen und Allergikern führen die Bisse zu Entzündungen der Haut, Asthma, Sehbeeinträchtigung bis hin zum anaphylaktischen Schock

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Phorodon humuli

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Leptinotarsa decemlineata, Kartoffelkäfer

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Bemisia tabaci, Weiße Fliege

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Panonychus ulmi, Rote Spinne

Sammelgebiet Bodenseeregion

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Nilaparvata lugens, Reiszikaden

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Musca domestica, Stubenfliege

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Anopheles gambiae (Malariamücke)

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Rapsernte und Produktion: EU Top-Länder (2009)

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Hauptschädlinge im Winterraps – Auftreten und (mögliche) Behandlungszeiträume

Wuchsstadium	Winterruhe						Saat	Keimung	Blattentwicklung		
Schädling	**Jan**	**Fe**				**l**	**Aug**	**Sep**	**Okt**	**Nov**	**Dez**
Rapserdfloh (Psylliodes chrysocephala)											
Rapsstängelrüssler (C. napi)											
Rapsglanzkäfer (Meligethes spp.)											
Kohlschotenrüssler (C. assimilis)											
Gefl. Kohltriebrüssler (C. pallidactylus)											
Kohlschotenmücke (D. brassicae)											
Mehlige Kohlblattlaus (B. brassicae)											
Grüne Pfirsichblattlaus (M. persicae)											

Vorblüte **Blüte** **Auflauf**

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Eigentliche Ursache des Problems war …

➡ es gab nur Pyrethroide!

1. Fastac 100 SC	*Alpha-Cypermethrin*
2. Karate Zeon 100 CS	*Lambda-Cyhalothrin*
3. Trafo 50 WG	*Lambda-Cyhalothrin*
4. Decis flüssig 25 EC	*Deltamethrin*
5. Ripcord 100 EC	*Cypermethrin*
6. Sumicidin Alpha 50 EC	*Esfenvalerate*
7. Baythroid 50 EC	*Cyfluthrin*
8. Bulldock 25 EC	*Beta-Cyfluthrin*

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Strukturelle Diversität von Pyrethroiden, aber gleiche Wirkungsweise

lambda-Cyhalothrin
Karate (1984)
1

Deltamethrin
Decis (1977)
1

Tau-fluvalinate
Mavrik (1984)
2

Permethrin
Ambush (1977)
1

Bifenthrin
Talstar (1986)
2

Ethofenprox
Trebon (1986)
2

Alle Pyrethroide binden an spannungs-abhängige Natriumkanäle im zentralen Nervensystem der Insekten

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Eine Wirkmechanismusklasse für alle Pyrethroide:

3A

Resistenzmonitoring (IRAC Methode 11)

IRAC Insecticide Resistance Action Committee
www.irac-online.org

- ❑ „Adult vial test“ (500, 100, 20, 4% der Feldrate)
- ❑ Referenzpyrethroid (λ-Cyhalothrin)
- ❑ Leichte Durchführung
- ❑ Robust und zuverlässig

IRAC Methode 11 – Röhrchentest

Pyrethroid Resistenzmonitoring Rapsglanzkäfer

IRAC Susceptibility Test Methods Series *Method No: 11*

Version: 1

resistant, resistant and highly resistant.

Concentration (% of label rate)	Affected	Classification	Code
100%	100%	Highly Susceptible	1
20%	100%		
100%	100%	Susceptible	2
20%	< 100%		
100%	<100% to > 90%	Moderaltey Resistant	3
100%	< 90% to > 50%	Resistant	4
100%	< 50%	Highly Resistant	5

IRAC Resistenzklassifizierung gilt NUR für PYRETHROIDE!

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Pyrethroid Resistenzmonitoring in Europa: Eine IRAC Initiative (Start 2007)

Research Article

SCI

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Pyrethroid resistance monitoring in European populations of pollen beetle (*Meligethes* spp.): a coordinated approach through the Insecticide Resistance Action Committee (IRAC)

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Gerald Huart,[e] Michel
Ralf Nauen,[h] Jean Luc

	2007	2008	2009	2010
Populationen	608	577	804	723
Länder	10	17	20	15
Käfer	120,000	115,000	160,000	145,000

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Pyrethroidresistenz in Glanzkäfern in Europa - 2011

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Publiziert, und weiter geht's…

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journal homepage: www.elsevier.com/locate/pest

Cytochrome P450 mediated pyrethroid resistance in European populations of *Meligethes aeneus* (Coleoptera: Nitidulidae)

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Und wieder publizieren

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Pesticide Biochemistry and Physiology

journal homepage: www.elsevier.com/locate/pest

Target-site resistance to pyrethroids in European populations of pollen beetle, *Meligethes aeneus* F.

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ABSTRACT

Pollen beetle, *Meligethes aeneus* F. (Coleoptera: Nitidulidae) is a major univoltine pest of oilseed rape in many European countries. Winter oilseed rape is cultivated on several million hectares in Europe and the continuous use of pyrethroid insecticides to control pollen beetle populations has resulted in high selection pressure and subsequent development of resistance. Resistance to pyrethroid insecticides in this pest is now widespread and the levels of resistance are often sufficient to result in field control fail-

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Austesten von Resistenzmanagement-Optionen in amtlichen Versuchen

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ÜBERSICHTSARTIKEL

Möglichkeiten der gezielten Bekämpfung von Pyrethroid-resistenten Rapsglanzkäferpopulationen – Ergebnisse von Ringversuchen mehrerer Bundesländer

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Brandenburg
Sachsen
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Trotz neuer Wirkmechanismen nimmt die Pyrethroid-resistenz in vielen Ländern weiter zu

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IRAC: Resistenzmanagement Empfehlung (2012)

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Vielen Dank
für Ihre
Aufmerksamkeit

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