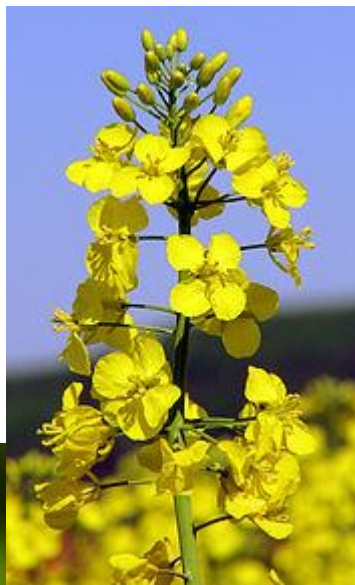
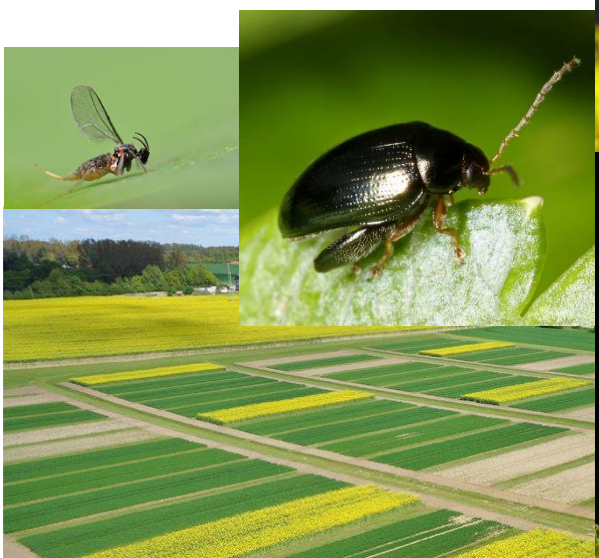
EPPO Workshop on Integrated Management of Insect Pests in Oilseed Rape

Julius Kühn-Institute
Berlin, 2017-09-20/22

EPPO Workshop 2017





European and Mediterranean Plant Protection Organization (OEPP/EPPO)

EPPO Workshop 2017

Programme

EPPO Workshop on Integrated Management of Insect Pests in Oilseed Rape

JKI, Königin-Luise-Straße 19, Berlin-Dahlem, Germany – Room A/300

Wednesday, September 20

08:15 **Registration**

OPENING MORNING SESSION

Welcome and Opening address

08:45 Welcome by JKI – Udo Heimbach
Vlasta Zlof - EPPO

Introductory presentations

Chair: Udo Heimbach

09:10 **Growers' perspective: importance of insect control for oilseed rape production**
Manuela Specht - UFOP, Germany

09:40 **Managing insect pests of canola in Canada**
Héctor A. Cárcamo – Agriculture and Agri-Food Canada

10:10 **The insect pests of oilseed rape: biology and potential for control by IPM**
Samantha Cook – Rothamsted Research, UK

Discussion on presentations

10:55 Coffee break

11:25 **Update on insecticide resistance mechanisms and potential cross-resistance issues in major insect pest in oilseed rape**
Ralf Nauen – Bayer, Germany

Discussion on presentation

Country presentations of current situation and recommendations on controlling oilseed rape insect pests with particular reference to resistance management

12:00 **Summary of findings from a participant country questionnaire on pest insects in oilseed rape**
Udo Heimbach – JKI, Germany

France: Alternative management of insect pests on oilseed rape in winter and spring Marc Delos – SRAL/ DRAAF-Occitanie & **Alternative management of insect pests on oilseed rape in autumn,** Laurent Ruck – Terres Inovia

Discussion on presentations

13:00 Lunch

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Wednesday, September 20

AFTERNOON SESSION

Country presentations with particular reference to resistance management (continued)

Chair: Susan Mattock

14:00
- **Oilseed rape pests in Norway** Nina Svae Johanses - NIBIO
- **Severe infestations of cabbage seed weevil and brassica pod midge in winter oilseed rape in Sweden** Gunilla Berg - Swedish Board of Agriculture
- **Resistance of pollen beetles to insecticides complicates control of cabbage stem weevils in winter oilseed rape in Czech Republic and Slovakia** Marek Seidenglanz - Agritec Plant Research & **Czech Plant Medicine Portal** Martina Sojnekova
- **Insecticide resistance of the most important insect pests in oilseed rape in Poland and resistance management strategies** Joanna Zamojska - Institute of Plant Protection
- **Pyrethroid resistance of insect pests in oilseed rape in Germany** Udo Heimbach

Discussion on presentations

15:30 Coffee break

16.00 Short presentations from:
- **Austria:** Gottfried Besenhofer - AGES
- **Lithuania:** Birute Vaitelyte - LAMMC
- **Serbia:** Željko Milovac – IFVC
- **Hungary:** István Farkas - Governmental Office County Vas

- **The role of UK Insecticide Resistance Action Group (UK-IRAG) and the British Crop Protection Council (BCPC) Pests and Beneficial Insects Group in resistance management and IPM in OSR** Sue Mattock - CRD

Discussion on presentation

Industry Presentations - Chemical control options, the status of available active substances including risk assessment concerning resistance to different substances

Chair: Ralf Nauen

17:00
- **Insecticide resistance monitoring results for thiacloprid obtained for pollen beetle populations collected in the EU between 2009 and 2017** Ralf Nauen - Bayer
- **Indoxacarb susceptibility monitoring of pollen beetles European populations** Stefano Pasquini - DuPont

Discussion on presentations

18:10 Close of the first day (Free evening)

European and Mediterranean Plant Protection Organization (OEPP/EPPO)

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Thursday, September 21

MORNING SESSION

Industry Presentations - Chemical control options (Continued)

Chair: Ralf Nauen

08:30

- **Combined use of Phosmet and new cropping systems to control cabbage stem flea beetles** Luc Westerloppe - Gowanco
- **Pymetrozine: An essential component of insect pest management in European oilseed rape crop production** Russell Slater - Syngenta
- **Cyantraniliprole insecticide seed treatment: a new and unique tool for integrated pest management in oilseed rape in Europe** Anita Van Nieuwenhoven - DuPont
- **Isoclast™ Active (sulfoxaflor) as a new tool for managing virus vectors and virus transmission in oilseed rape** Imre Mezei - DowAgroSciences
- **Integral Pro: a tool within an Integrated Pest Management** Myriam Siham - BASF

Discussion on presentations

Control of autumn pests after the loss of neonicotinoid seed treatment in oilseed rape

Chair: Marc Delos

10:00 **Are there alternative insecticidal products after the ban of neonicotinoid seed treatment?** Nils Conrad – JKI, Germany

10.20 **Monitoring of the UK's 2015/16 neonicotinoid derogation for oilseed rape** Sacha White – ADAS, UK

Discussion on presentations

10.45 Coffee break

11.00 **Reacting to the threat to the oilseed rape crop from the cabbage stem flea beetles, in the UK, in the absence of neonicotinoid seed treatments** Simon Kightley – NIAB,UK

11.20 **Is resistance to insecticides affecting the interaction between aphids and Turnip Yellows Virus?** Nadine Drechsler – BTL Bio-Test Labor, Germany

Discussion on presentations

Improving pesticide use

Chair: Lovisa Eriksson

11.50 **Using dropleg technique during flowering of oilseed rape to avoid pollinator exposure** Johannes Hausmann - JKI, Germany

12.05 **Effects of insecticide applications on population development of pollen beetle in field studies** Meike Brandes - JKI, Germany

12.20 **Current use and development of expert weather-based phenological models for managing oilseed rape pests in autumn and spring** Maria Tackenberg (Andreas Johnen) - Bayer Digital Farming, Germany

Discussion on presentations

13.00 Lunch

European and Mediterranean Plant Protection Organization (OEPP/EPPO)

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Programme

Thursday, September 21

AFTERNOON SESSION

Integrated Pest Management

Chair: Samantha Cook

Biological control

14:00 **Identity of parasitoids and their potential for biocontrol of oilseed rape pests in Europe** Bernd Ulber - University of Göttingen, Germany

14:30 **Long term effects on parasitic wasps of insecticides used to control the pollen beetle** Jean-Pierre Jansen – CRA Wallonie, Belgium

14:50 **Can entomopathogenic nematodes contribute to the sustainable management of oilseed rape pest insects?** Ralf-Udo Ehlers – e-nema, Germany

15:10 **Effects of entomopathogenic nematodes on insect pests of oilseed rape** Johannes Hausmann – JKI, Germany

Discussion on presentations



15:45 Close of the second day

16:00 – 22:00 Evening programme

A river tour will be provided by the ADAMA, Bayer CropScience and Syngenta

The boat trip will lead to a dinner offered by the Union for the Promotion of Oil and Protein Plants of Germany (UFOP)

ADAMA

Bayer CropScience

syngenta

ufop

European and Mediterranean Plant Protection Organization (OEPP/EPPO)

EPPO Workshop 2017

Programme

Friday, September 22

MORNING SESSION

Integrated Pest Management

Chair: Vlasta Zlof

8:45 **EMPHASIS project: IPM for seedling insects in winter and spring oilseed rape production** Inga Gaile – Integrētās Audzēšanas Skola, Latvia

9:05 **IPM4Meligethes ERA-NET project: new approaches to resistance management** Heikki Hokkanen - University of Helsinki, Finland

9:25 **Socioeconomics of adopting IPM strategies by oilseed rape farmers** Ingeborg Menzler-Hokkanen - University of Helsinki, Finland

9:45 **An Integrated Pest Management strategy for pollen beetle – are we nearly there yet?** Samantha Cook - Rothamsted Research, UK

10:05 **Monitoring and IPM of cabbage stem flea beetle in the UK** Sacha White – ADAS, UK

Discussion on presentations

10.40 Coffee break

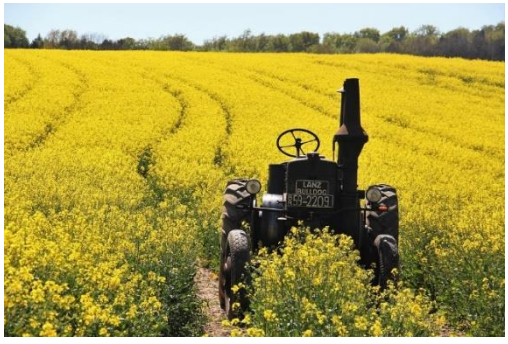
Host plant resistance (breeding)

Chair: Vlasta Zlof

11.00 **Breeding for insect resistance in oilseed rape: is it a dream?** Maxime Hervé – University of Rennes, France

11.30 **Turnip yellows Virus in oilseed rape – multi-annual European monitoring of disease pressure, estimation of yield impact and proposal of a genetic solution** Wolfgang Lüders – Limagrain, Germany

Discussion on presentations



12.00 **CONCLUSIONS**

12.30 **Close of the Workshop**

European and Mediterranean Plant Protection Organization (OEPP/EPPO)

Julius Kühn-Institut
Federal Research Centre for Cultivated Plants

ABSTRACTS

EPPO Workshop on integrated management of insect pests in oilseed rape

JKI, Berlin, 2017-09-20/22

Background

At the EPPO Workshop on insecticide resistance of *Meligethes* spp. (pollen beetle) on oilseed rape (Berlin, 2007)[1], it was recommended that follow-up should be planned to include other oilseed rape pests. The Panel on Resistance and the Working Party on Plant Protection Products welcomed the German proposal to organize a Workshop on integrated management of insect pests in oilseed rape.

The most important oilseed rape insect pests in Europe are:

EPPO code	Preferred scientific name	Common name	Other scientific names
MELIAE	*Brassicogethes aeneus*	pollen beetle	*Meligethes aeneus*
CEUTNA	*Ceutorhynchus napi*	rape stem weevil	
CEUTAS	*Ceutorhynchus obstrictus*	cabbage seed weevil	*C. assimilis*[2]
CETQU	*Ceutorhynchus pallidactylus*	cabbage stem weevil	*C. quadridens*
CEUTPI	*Ceutorhynchus picitarsis*	rape winter stem weevil	
PSYICH	*Psylliodes chrysocephala*	cabbage stem flea beetle	
DASYBR	*Dasineura brassicae*	brassica pod midge)	
MYZUPE	*Myzus persicae* (vector of Turnip Yellows Virus)	green peach aphid	

Among these insects selection pressure for developing insecticide resistance is high, as they need to be controlled at different times during the growth of oilseed rape resulting in the need for several applications. Therefore, when these pests are present in the crop they are often affected by more than one insecticide application targeted to other species. In recent years, in several EPPO countries, resistance to different insecticides has been building up in particular against pollen beetle, cabbage seed weevil, green peach aphid and cabbage stem flea beetle. The resistance pressures have become further complicated by the limitations on available chemistry as foliar and seed treatments.

While several countries have worked to develop management strategies for the various oilseed rape pests, lack of communication prevents other countries from learning from their experiences.

The aim of this Workshop is to share knowledge, inform participants about current integrated pest management techniques and identify gaps in knowledge and research needs, avoid unnecessary duplication of work (e.g. resistance monitoring efforts), support the development of recommendations on resistance management for EPPO member countries.

Your active participation is crucial, please do not hesitate to speak, raise questions, share your knowledge and experience!

[1] http://archives.eppo.int/MEETINGS/2007_meetings/meligethes/meligethes_workshop.htm

[2] Taxonomic confusion took place for many years between *C. assimilis* and *C. pleurostigma*. It is currently considered that the turnip gall weevil is *C. assimilis* (formerly known as *C. pleurostigma*) and that the cabbage seed weevil is *C. obstrictus* (formerly known as *C. assimilis*).

Growers' perspective: importance of insect control for oilseed rape production

Manuela Specht

Union for the Promotion of Oil and Protein Plants (UFOP), Claire-Waldoff-Straße 7, 10117 Berlin, Germany

Rapeseed continues to be an important component of agricultural production in the EU-28. On average 6 % of arable land is grown with rape and turnip rape seed. The countries with large areas are France, Germany, Poland, the United Kingdom, Romania and the Czech Republic. The countries with the highest percentage rape and turnip rape seed of their arable land are the Czech Republic (15-17 %), Estonia (11-14 %), Germany (11-12 %) and the United Kingdom (11-12 %). Rape and turnip rape crops cover the soil for 11/12 months. The plants are attacked by several insect pests during autumn and spring time. Resistance against pyrethroids is very widespread. In most countries there is a lack of alternative active substances. The withdrawal of neonicotinoids for seed treatment in 2013 increased the problems during the establishment of young plants. More and more farmers lose yield due to failure of insecticide spraying or growing rapeseed becomes unsuccessful. This is why the risk and the costs of cultivation are increasing. Rape seed and turnip rape seed production when there is a lack of effective control of insect pests becomes more and more unattractive.

Managing insect pests of canola in Canada

Héctor Cárcamo (1), Owen Olfert (2), Alejandro Costamagna (3), Tharshi Nagalingam, (3), Jennifer Otani (4) and Geneviève Labrie (5).

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(2) Agriculture and Agri-Food Canada, Saskatoon, Saskatchewan, Canada
(3) University of Manitoba, Winnipeg, Manitoba, Canada
(4) Agriculture and Agri-Food Canada, Beaverlodge, Alberta, Canada
(5) Centre de Recherche sur les grains, Saint-Mathieu-de-Beloeil, Quebec, Canada

Canola is a key cash crop planted on 8-9 M ha annually in Canada. The most serious pests are flea beetles that feed on seedlings. *Phyllotreta cruciferae* used to be the dominant species and little damage was observed because almost all seed is planted with a neonicotinoid insecticide coating. Recently, *P. striolata* has become dominant in the humid regions and many growers spray insecticides to manage it. During the flower stage, seedpod weevil (*Ceutorhynchus obstrictus*) is a chronic pest in the south west prairie region. In Quebec, this pest is managed by an adventive parasitoid from Europe – *Trichomalus perfectus*. Relocation of this parasitoid to western Canada is being considered to replace insecticides. Other sporadic pests attack the crop at various stages: *Lygus bugs* (*Hemiptera*: *Miridae*), bertha armyworm and other cutworms (Lepidoptera: *Noctuidae*), diamondback moth (Lepidoptera: *Plutellidae*), red turnip beetle (*Chrysomelidae*), and wireworms (*Elateridae*). The Prairie Pest Monitoring Network is an informal alliance of researchers, industry and extension personnel that monitors hundreds of sites throughout the three Prairie Provinces to forecast potential pests that may develop in an area. It also provides long term data sets to analyze effects of weather on pest populations and provide insight on climate change impacts on key pests. There are no documented cases of insecticide resistance for canola pests in Canada.

The insect pests of oilseed rape: biology and potential for control by IPM

Samantha Cook

Biointeractions and Crop Protection Department, Rothamsted Research, Harpenden, Hertfordshire, UK.

Surveys in the UK have shown the importance of the oilseed rape (OSR) crops to a wide variety of invertebrates. The most abundant were brassica specialist pests, but the crop also supports a great diversity of beneficial insects including the brassica-specialist parasitoids of OSR pests and generalist predators such as ladybirds, lacewings and hoverflies. The diversity and abundance of invertebrates associated with the crop implies that, even when conventionally managed, it plays an important role in supporting populations of butterflies and pollinators, natural enemies of crop pests, and in maintaining food resources for farmland birds throughout the arable rotation. This potential could be harnessed further via use of Integrated Pest Management (IPM) approaches which minimise insecticide use. IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of practices (including the judicious use of pesticides). There are four usual steps in IPM programmes: 1. Set action threshold 2. Monitor pest density & assess risk 3. Prevention – cultural methods e.g. crop rotation, use of pest-resistant cultivars; semiochemical e.g. pheromone repellents; habitat diversification e.g. intercropping, trap cropping 4. Control – mechanical (e.g. trapping); botanical; biological; conservation biocontrol (i.e. the encouragement of naturally-occurring enemies of crop pests to provide pest-regulation services in the crop); synthetic insecticides as a last resort. I will introduce the major insect pests of oilseed rape, detailing their life cycle and behaviours. I will then discuss the four steps of IPM programmes giving details and examples of each, with focus on my work on pollen beetles (*Meligethes aeneus*), cabbage seed weevils (*Ceutorynchus obstrictus*) and cabbage stem flea beetles (*Psylliodes chrysocephala*).

Update on insecticide resistance mechanisms and potential cross-resistance issues in major insect pests of oilseed rape

Ralf Nauen

Bayer AG, Crop Science Division, Pest Control, Alfred Nobel Str. 50, 40789 Monheim, Germany

Oilseed rape is attacked by a number of invertebrate pests of the order Coleoptera, such as flea beetles (*Psylliodes* ssp., *Phyllotreta* ssp.), stem weevils and seed pod weevils (*Ceutorhynchus* ssp.) and pollen beetle (*Meligethes* ssp.). However the recent ban on neonicotinoid seed treatment has been followed by an increase in pest aphids in autumn, particularly *Myzus persicae*. *Meligethes aeneus* F. is by far the most destructive species attacking oilseed rape crops throughout Europe and large scale application of chemical insecticides, particularly pyrethroids - acting on voltage-gated sodium channels in the insect central nervous system- led to the development of resistance in pollen beetle, but also other Coleopteran pests of oilseed rape, such *Psylliodes chrysocephala*. Insecticide resistance most commonly evolves by two main mechanisms; increased levels of detoxification enzymes resulting in metabolic resistance, and target-site mutations resulting in lower binding affinity of the respective insecticides. Pyrethroid resistance can be conferred by both mechanisms, but target-site insensitivity caused by mutations in the voltage-gated sodium channel, known as (super) knock-down resistance ((s)*kdr*), is a common mechanism in many pests including for example *P. chrysocephala* and *M. persicae*. Whereas metabolic resistance to pyrethroids conferred by an overexpression of cytochrome P450s is most common in *M. aeneus*. The objective of the presentation is to review recent findings on mechanisms of resistance and cross-resistance in major insect pests of oilseed rape in Europe.

Summary of findings from a participant country questionnaire on pest insects in oilseed rape

Udo Heimbach

Julius Kühn-Institut, Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Messeweg 11-12, 38104 Braunschweig, Germany

A questionnaire was sent to all EPPO countries in 2017 to gain some background information on oilseed rape growing and on pest insect control for oilseed rape. Information was sought on the use of thresholds, the availability of active substances and on the year in which resistance, if present, had been observed. A summary of the main findings of the questionnaire are presented. In total 10 countries responded (AT, CZ, DE, FR, GB, HU, LV, PL, SE, SK) with an oilseed rape growing area of about 5,400,000 ha (about 80 % of the EU oilseed rape growing area) of which less than 150,000 ha was summer oilseed rape. The number of insecticide applications per growing season in winter oilseed rape is on average more than 3 but varies between countries (1.5 – about 6) and with only 2 countries clearly above 3. Pyrethroid resistance in pollen beetle was reported for 9 countries, in cabbage stem flea beetle and in the green peach aphid for 5, in *Ceutorhynchus picitarsis* for 2 and in *C. obstrictus* for 1 country. However, for 1 country no resistance information was available and for most of the pest species no resistance information was provided. Information presented shows the range of active substances and doses recommended and the frequency of use of insecticides on oilseed rape and non-chemical control alternatives.

Alternative management of insect pests on oilseed rape in winter and spring

Laurent Ruck (1), Céline Robert (2) and Marc Delos (3)

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In winter and spring agronomical tools are limited for management of pests on oilseed rape. Since the resistance of *Meligethes* to pyrethroids occurred, in the case of moderate attacks of pollen beetle (*Meligethes aeneus*), as described in 2007, the association of 5-10% of a high and early flowering cultivar mixed with the cultivar of interest may allow pest levels on the crop to be kept below intervention thresholds. This technique exploits the pest preferences for the flowering growth stage (trap plants) which concentrate the pest onto the early flowering rape and away from the damage-susceptible growth stage (PULL Strategy). This high and early variety is more attractive for *Meligethes*. Trials with earlier flowering cultivars of winter rape used as a trap on 5 or 10 ranks beside the rape crop were conducted between 2006 and 2010. With a clear separation between the trap and the crop, destruction of numerous pollen beetles on the trap crops, with adequate insecticide before the pollen beetles re-emigrate onto the crop (PULL and DESTROY strategy) provided a better efficacy, but it was not easy enough to apply and it was not adopted by the growers. The first objective, as is the case for main autumn pests, is to get strong rape crops: quick and continuous growth during the season, early sowing, adequate amount of nitrogen, and avoid accidents that could reduce growth. Strong rape crops compensate for *Meligethes* damage on flower buds. The importance of autumn pests increases, but, pollen beetle damage to rape decreased since 2007 in France, so although more complex tools to control *Meligethes* exist, growers are not choosing to use them.

Alternative management of insect pests on oilseed rape in autumn

Laurent Ruck (1), Marc Delos (2) and Céline Robert (3)

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Winter oilseed rape is visited by many insects: pests, pollinators, natural enemies of pests. In France, the main insect pests are either *Coleoptera* or *Hemiptera*. Some pests have developed resistance to insecticides. The green peach aphid (*Myzus persicae*) is the main vector of the Turnip yellows virus (TuYV), one of the most significant viral disease of oilseed rape. This aphid is resistant to pyrethroids and carbamate. Tolerant varieties are available and Terres Inovia is evaluating their benefit against TuYV in comparison with insecticide treatment (ongoing work). In autumn cabbage stem flea beetle (*Psylliodes chrysocephala*) and rape winter stem weevil (*Ceutorhynchus picitarsis*) are the two major beetle pests. Since 2009/2010, their control has become more and more difficult. It was confirmed that populations of these two pests are resistant to pyrethroids and that several mechanisms can be involved: knock-down resistance (kdr), Super knock down resistance (skdr) or metabolic resistance. These three mechanisms seem to confer different levels of resistance in the fields. More than ever, the management of these two pests cannot rely only on insecticides. Agronomical tools are necessary to reduce their damage. The first objective is to succeed in having a quick and continuous growth of the crop in autumn and at the beginning of spring, this involves: early sowing (BBCH growth stage 14 must be observed before flea beetles flights), providing the adequate amount of nitrogen for correct growth, association with a frost sensitive legume crop, paying attention to phytotoxicity or to any accident that could reduce growth. The seedbed can be rolled as another tool against cabbage stem flea beetle.

Oilseed rape pests in Norway

Nina Svae Johansen, Annette Folkedal Schjøll, Gunda Thöming and Wendy Waalen

Norwegian Institute of Bioeconomy Research (NIBIO), Høgskoleveien 7, 1430 Ås, Norway

Oil seed rape (OSR) covers 4160 ha (87 % spring rape, and 13 % winter rape) in South-East Norway. Major pests are pollen beetles (*Meligethes* spp.) and flea beetles (*Phyllothreta* spp. and *Psylliodes chrysocephala*). Pests are controlled by insecticides according to a treatment threshold (pollen beetles) and by appearance in the field (flea beetles, diamondback moth *Plutella xylostella*, brassica pod midge *Dasineura brassicae*, turnip seed weevil *Ceutorhynchus assimilis*, cabbage stem weevil *Ceutorhynchus pallidactylus* and turnip sawfly *Athalia rosae*). Pyrethroids, thiacloprid and indoxacarb are available for pollen beetle control, and are applied 1-2 times before BBCH growth stage 57 on ca. 70 % and 10 % of the area with spring and winter rape, respectively. Indoxacarb is mainly used when the action threshold is exceeded. Indoxacarb and thiacloprid are also used in vegetables, where pollen beetles can be exposed as well. Only pyrethroids can be used against most other OSR pests. Pyrethroid resistance in pollen beetles was first suspected in 2006, and was confirmed the following years. Thiacloprid were introduced for pollen beetle control in 2008 and indoxacarb in 2010, and the growers in areas with pyrethroid resistance switched to these new actives. Decreased susceptibility to thiacloprid has recently been found at some locations, whereas indoxacarb is still very effective against pollen beetles. Insecticide resistance in other oil seed rape pests has not been investigated. R&D on OSR pests currently focuses on pollen and flea beetles, including trap crops, resistance monitoring and dynamics, and IPM guidelines.

Severe infestations of cabbage seed weevil and brassica pod midge in winter oilseed rape in Sweden

Gunilla Berg (1) and Lovisa Eriksson (2)

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(2) Swedish Board of Agriculture, Plant Protection Centre, Linköping, Sweden

Sweden has a long history of growing oilseed rape and already grew a large area in the 1940s. Both winter oilseed rape (WOSR) and spring oilseed rape (SOSR) are grown. WOSR is most common in the southern part and during the last five years WOSR has increased further north as SOSR has decreased. The most important insect pests in WOSR have been cabbage stem flea beetle (*Psylliodes chrysocephala*) and in some years pollen beetle (*Meligethes aeneus*). Severe problems with cabbage seed weevil (*Ceutorhynchus obstrictus*) and brassica pod midge (*Dasineura brassicae*) have been rare. The last severe infestation in southern Sweden occurred in the beginning of the 1970s and in 1992 for mid Sweden. During the last three years severe damage from brassica pod midge and cabbage seed weevils have been common in southern Sweden. In order to investigate the damage caused by brassica pod midge, surveys have been carried out in farmers' fields (35 fields checked for damage in the field). The results showed on average 10 % damaged pods in 2015, 28 % in 2016 and 16 % in 2017. The damage is always much more pronounced at the field edge so the numbers for the field edge are much higher. The presence of cabbage seed weevil has also increased and in many fields the numbers were well above the threshold of 1-2 weevils/plant. Insecticides are used for control, but timing is difficult and the efficacy is variable. The reasons for the sudden increase in presence and damage are unclear, but the increased area of WOSR and favourable weather could be of importance.

Resistance of pollen beetles (*Brassicogethes aeneus*) to insecticides complicates control of cabbage stem weevils (*Ceutorhynchus pallidactylus*) in winter oilseed rape crops

Marek Seidenglanz (1), Jaroslav Šafář (1), Pavel Kolařík (2), Eva Hrudová (3), Jiří Havel (4), Ján Táncik (5), Peter Bokor (5), František Kocourek (6), Nikoleta Rubil (7), Jakub Beránek (8) and Martina Sojneková (8)

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Lambda-cyhalothrin resistant pollen beetles are widely distributed in the Czech Republic (CZ) and Slovakia (SK) with 50% and 57% of respective populations resistant and 45% and 14% of respective populations highly resistant in 2016. CZ pollen beetle populations have also showed high variability in susceptibility to thiacloprid. In some seasons, positive significant correlations between resistance to lambda-cyhalothrin and lower susceptibility to thiacloprid were recorded (2012, 2014, 2015). CZ and SK pollen beetle populations have showed high susceptibility to chlorpyrifos-ethyl and indoxacarb. Seed pod weevils (*C. obstrictus*) and cabbage stem weevils (*C. pallidactylus*) seem to be markedly less susceptible to indoxacarb (CZ 2016 LC_{50} medians for the two species: 18.53 resp. at 17.64 $g.ha^{-1}$) than pollen beetles (CZ 2016 LC_{50} median: at 0.83 $g.ha^{-1}$) and flea beetles (CZ 2016 LC_{50}: below 0.20 $g.ha^{-1}$). Flea beetles (*P. nigripes* - predominant) have been markedly less susceptible to thiacloprid than seed pod and cabbage stem weevils (CZ 2016 LC_{50} median for the species: 2.16 $g.ha^{-1}$) and pollen beetles (CZ 2016 LC_{50}median: 6.46 $g.ha^{-1}$). Insecticides with sufficient efficacy against *C. pallidactylus* and *B. aeneus* are needed for the first spring application (dissection of *C. pallidactylus* ovaries enables timing of application). Pyrethroid resistance and doubts about suitability of neonicotinoids for use as an alternative for them and low susceptibility of *C. pallidactylus* to indoxacarb substantially limits the number of suitable insecticides for such applications. In reality it means that chlorpyrifos-ethyl has been used almost exclusively for the first spring applications in CZ and SK.

Insecticide resistance of the most important insect pests in oilseed rape in Poland and resistance management strategies

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The pollen beetle and the cabbage seed weevil are among the most dangerous winter oilseed rape pests in Poland and other European Union countries. Each year these species may cause considerable loss to the oilseed rape yield, creating a need for intensive chemical protection. Control of the pests in Poland includes the use insecticides from the chemical groups: pyrethroids, neonicotinoids, organophosphorous compounds, oxadiazines and pyridine azometines. Frequent insecticide treatments in rapeseed plantations in Poland create a heavy selective pressure enhancing resistance appearance and development. Moreover, both pests, despite a similar history of control, demonstrate quite different susceptibility level to pyrethroids and oxiadiazines, which makes their management more complicated. In later BBCH growth stages, both species can often be found together in oilseed rape fields and treatments aimed at the cabbage seed weevil control create selective pressure towards pollen beetle resistance as well. Many problems cannot be avoided but their negative effects can be minimised by the use of proper resistance management strategies. The presentation describes the current susceptibility levels of the pollen beetle and the cabbage seed weevil to most insecticides recommended in Poland. Also, taking into account the above mentioned problems it includes a proposal for a resistance management strategy and the proposed sequence of insecticides use in oilseed rape plantations in the spring season in Poland. Some information on aphids as a new resistance problem in oilseed rape in Poland will also be presented.

Pyrethroid resistance of insect pests in oilseed rape in Germany

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In oilseed rape several insect species can cause damage and often control measures are taken. For many years only pyrethroids were authorised for spray applications. Rumours of pyrethroid resistance of pollen beetle (*Brassicogethes aeneus*) arose in 1999 in France. A biotest was established in Germany in 2004 and the sensitivity of different species was monitored. At first pollen beetle resistance was mainly detected in the north and west but within a few years spread all over the country. The extent of resistance is still increasing and pyrethroids, such as cyhalothrin, are no longer expected to have any field efficacy. Other pyrethroid types (etofenprox, tau-fluvalinate, bifenthrin not authorised in DE) still provide some field efficacy but biotest sensitivity is decreasing. Resistance in cabbage stem flea beetle (*Psylliodes chrysocephala*) was detected in 2010 after control failures in the field. This resistance, now known to be of kdr type, has spread over DE nowadays but pyrethroids are still effective (resistance factor about of 25, compared to more than 200 for pollen beetle). At about the same time as for *P. chrysocephala* field failures were reported for Cabbage stem weevil (*Ceutorhynchus obstrictus*) and biotests showed reduced sensitivity. This resistance has spread over DE in the meantime with resistance factors up to about 70. In a sample of *Ceutorhynchus picitarsis* kdr has been detected. No sensitivity shifts were detected yet for *C. napi*, *C. pallidactylus*, *Phyllotreta* spp. and *Dasineura brassicae*. Resistance strategies were implemented to address the needs for damage control as well as to slow down resistance development.

Short presentations on the current situation and recommendations on controlling oilseed rape insect pests in the following countries:

Austria, Gottfried Besenhofer**,** *Austrian Agency for Health and Food Safety (AGES), Institute for Plant Protection Products, Vienna*

Lithuania, Birute Vaitelyte**,** *Lithuanian Research Centre for Agriculture and Forestry (LAMMC), Institute of Agriculture, Akademija*

Serbia, Željko Milovac, *Institute of Field and Vegetable Crops (IFVC), Novi Sad*

Hungary, Istvan Farkas, *Governmental Office County Vas*

The role of UK Insecticide Resistance Action Group (UK-IRAG) and the British Crop Protection Council (BCPC) Pests and Beneficial Insects Group in Resistance management and IPM in OSR

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Insect control using conventional insecticides is increasingly challenging across Europe. Their prolonged use has led to increasing resistance problems which, combined with significant loss of chemistry through the regulatory regime, has limited the effective options in any one crop/target. There are now difficult challenges in implementing robust resistance management strategies. It is therefore critical that all stakeholders work closely together, sharing research, information, and expertise in providing advice to growers on IPM. The UK-Resistance Action Groups (UK-RAG's) are long established, including the UK-Insecticide Action Group (IRAG) founded in 1997. They have cross-stakeholder representation including regulatory (HSE-Chemicals Regulatory Division), researchers, industry, independent agronomists, and growers (Agricultural and Horticultural Development Board, AHDB). The purpose of UK-IRAG is to exchange and interpret resistance information, produce resistance guidance for growers, identify knowledge gaps, and establish links in other countries and with IRAC. The UK would like to find ways to encourage more Member State national RAG groups becoming active, to assist in dissemination of information, resistance monitoring and sharing experiences. The British Crop Protection Council (BCPC) 'Pests and Beneficials' Working Group was formed in 2015 to discuss relevant research, new legislation and impact on IPM. The group organises yearly reviews. They first discussed the future of OSR growing and impact of the neonicotinoid restrictions. The second review examined the lessons learnt from the pyrethroid story since their approval, and implications for an IPM future.

Insecticide resistance monitoring results for thiacloprid obtained for pollen beetle populations collected in the EU between 2009 and 2017

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Over the last ten years a few new active ingredients with different modes of action (MoA) were registered for insect pest control in oilseed rape, including thiacloprid (Insecticide Resistance Action Committee (IRAC) MoA Group (4A), which agonistically binds to insect nicotinic acetylcholine receptors. Other insecticides recently registered for pollen beetle control in some European countries include acetamiprid (4A), indoxacarb (22A) and pymetrozine (9B). However, in Germany by far the most important insecticide after pyrethroids is thiacloprid, which is active against pollen beetle, *Meligethes aeneus*, as well as weevils such as *Ceutorhynchus obstrictus.* The presentation summarizes the susceptibility status to thiacloprid of *M. aeneus* populations collected all-over Europe between 2009 and 2017 and highlights the importance of annual resistance monitoring programmes in an intensively (insecticide) managed crop such as winter oilseed rape.

Indoxacarb susceptibility monitoring of pollen beetles (*Meligethes aeneus*) European populations

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(2) DuPont de Nemours ERDC, 24 rue du Moulin, 68740 Nambsheim, France
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The pollen beetle (*Meligethes aeneus*), also known as blossom beetle, is one of the most important insect pests on European oilseed rape (OSR), causing significant crop damage and yield losses. Control of this pest mainly relies on applications of chemical insecticides. In 1999 first resistance of *M. aeneus* to pyrethroids (IRAC scheme MoA3) was reported and has, since then, spread over Europe. More recently lower susceptibility to neonicotinoids (MoA4) was reported by IRAC for some populations. These findings underline the importance of an effective resistance management strategy to delay or avoid occurrence of resistance. Indoxacarb is an oxadiazine insecticide (MoA22) widely used to control pollen beetle before flowering, combining high control of the pest with IPM compatibility. So far it is the only MoA22 insecticide registered on OSR to control *M. aeneus* adults. Results of monitoring executed in 2016 by DuPont and collaborators in main OSR cultivating countries across Europe are presented, in order to detect possible susceptibility shifts of *M. aeneus* to indoxacarb. Susceptibility of tested populations to indoxacarb was evaluated using the vial test method IRAC No. 027. Moreover, from 2008 to 2016, a total of 318 populations were collected from commercial fields in major European OSR-cultivating countries. Results of the monitoring showed no change in the susceptibility of *M. aeneus* populations to indoxacarb, underlining the importance of this active in the pest control program and the resistance management strategy.

Combined use of phosmet and new cropping systems to control cabbage stem flea beetles

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Cabbage stem flea beetle (*Psylliodes chrysocephala*) has become an important problem in France for oilseed rape crops. Strong attacks of beetles which are difficult to control have led to early destruction of rapeseed crops in September or October. In other cases, high numbers of larvae inside the stems can lead to the destruction of the plant's heart causing bushy plants or their complete regressions before spring regrowth. In 2013, Gowan commissioned Terres Inovia to evaluate Boravi WG, an insecticide based on Phosmet (organophosphate) against *P. chrysocephala*. Results from 6 trials have shown its potential in controlling attacks by adults and its activity against larvae in late application. These trials have alerted us to the limited number of effective solutions and to the fact that, in the future, it will be necessary to reduce the number of applications in order to maintain effective insecticide solutions. In the autumn of 2016, 3 trials were implemented to evaluate the benefit of combining agronomic techniques and insecticide strategies. 3 agronomic strategies and 4 insecticidal strategies were combined within a split-plot device. Only one of these trials had a sufficient pest pressure. This trial showed that the use of field bean as a companion crop can reduce cabbage stem flea beetle pressure and ultimately the number of larvae/plant.

Pymetrozine: an essential component of insect pest management in European oilseed rape crop production

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The availability of a diverse range of pest control measures is essential for the sustainable production of many agricultural crops. This particularly true in the case of oilseed rape, where the control of a wide range of insect pests has in the past been heavily reliant upon a single class of chemical insecticides. Pyrethroid insecticides have almost been the sole solution for oilseed rape pest control for nearly half a century and this has inevitability lead to the development of resistance in several of the key pests. In order to prevent a repeat of the circumstances that has driven the selection of resistance, a diverse range of control measures and their deployment is required. One such solutions is the pyridine azomethine insecticide, pymetrozine. Pymetrozine (PLENUM 50WG) offers an alternative mode of action to other insecticide solutions currently registered for pest control in European oilseed rape. As a modulator of chordontonal organ TRPV channels, it controls both pollen beetle and aphids in oilseed rape. Alongside other insecticides with alternative modes of action and in conjunction with biological and cultural methods of pest control, pymetrozine offers a longer term solution to oilseed rape pest management compared with over reliance on a single method of control. However, regulatory policy may place insecticide mode of action diversity at risk and this should be avoided in order to prevent a repeat of the pyrethroid story.

Cyantraniliprole insecticide seed treatment: a new and unique tool for integrated pest management in oilseed rape in Europe

Anita van Nieuwenhoven

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The insecticide seed treatment with the active ingredient cyantraniliprole (DuPont™ Lumiposa®) offers a new mode of action for seed treatment that serves as a first line of defence in an integrated pest management program in oilseed rape. It helps in managing early-season cabbage root fly, cabbage stem flea beetle, flea beetle and turnip sawfly, resulting in better early crop establishment.

Cyantraniliprole belongs to the anthranilic diamide insecticide class (IRAC Group 28). It is a systemic insecticide and mobile via xylem. Insects are affected when they feed on the treated plant.

Seed treatment with cyantraniliprole 625 g/L FS (Lumiposa®) at 50 µg a.s./seed is registered for use in winter oilseed rape in Poland.

In order to reduce the risk of the development of resistance to this alternative mode of action, a set of insecticide resistance management (IRM) avoidance recommendations is implemented.

Methods for testing the susceptibility of the targets *Psylliodes chrysocephala* and *Delia radicum* have been developed. For *P. chrysocephala* a method based on IRAC Method #027 is validated and now used for monitoring susceptibility. For *D. radicum,* validation of a method based on IRAC Method #026 Version 1 is ongoing.

Isoclast™ Active (sulfoxaflor) as a new tool for managing virus vectors and virus transmission in oilseed rape

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Winter and spring oilseed rapes are important crops in the European Union with a yearly production of approximately 30 million tonnes. This production is endangered by several aphid pests that are increasing in importance as vectors of virus diseases. *Brevicoryne brassicae* is the dominant aphid species in brassica crops but recently *Myzus persicae* has become more problematic as a vector of the Turnip yellows virus (TuYV), which can decrease yields up to 40% when young plants are infected in the autumn. Several other viruses could be transmitted by this species on oilseed rape such as TUMV (Turnip mosaic virus) and CAMV (Cauliflower mosaic virus). Effective and fast control of vectors is crucial to prevent or at least mitigate virus transmission and damage caused by the viruses. Isoclast tested in several lab and open field trials effectively controlled virus vector aphids resulting in significant prevention of virus transmission. This effect is achieved by a very fast feeding cessation followed by pest mortality, which results in low virus infection in the field and significant yield increase in comparison to the untreated controls. Across Europe, *M. persicae* has developed resistance to many classes of insecticides including neonicotinoids, pyrethroids, carbamates and OPs which has created a challenge for effective control of this pest. Laboratory and field studies demonstrate that Isoclast delivers effective control of *M. persicae* against resistant strains and offers a solution for this problem.

Integral Pro - A tool within an integrated pest management

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There is a remarkable gap between the potential yield of new oilseed rape (OSR) varieties and the ones growers normally achieve. Growers need to optimize every step in cropping to reach this potential. However lack of insecticides for seed treatment against flea beetle, virus transmission through aphids and cabbage root fly, plus shorter crop rotation forces growers to increase foliar application of insecticides and fungicides, which leads to increased risks of resistance development.

Therefore enhancing the crop establishment is a key factor that contributes to yield improvement.
Integral Pro is a seed treatment based on the bacteria *Bacillus amyloliquefaciens* strain MBI600. Through its complex mode of action, it triggers several plant defense mechanisms. This allows the seedlings to better resist to soil borne pathogens, to be more vigorous, and achieve a higher emergence rate, which can contribute to a lesser impact of pest attacks in earlier stages.
As many chemical plant protection products disappear from the market due to regulatory issues, microorganism-based products, despite the variability of their efficacy, can be a tool among others within an integrated pest management strategy.

Are there alternative insecticidal products after the ban of neonicotinoid seed treatment?

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After the ban of the neonicotinoid seed treatment in winter oilseed rape in 2013 in the European Union the control of autumn pest insects relies only on pyrethroids. To investigate the influence of the ban on the population dynamics and the damage potential of the main autumn pests, field trials were established near Braunschweig in the growing seasons 2015/2016 and 2016/2017. Four different insecticides were tested in the field trials: 1. Karate Zeon (lambda-cyhalothrin) in the autumn of both growing seasons, 2. Elado (clothianidin + beta-cyfluthrin) in the autumn of both growing seasons, 3. Fortenza Force (cyantraniliprole + tefluthrin) in 2015 and 4. Lumiposa (cyantraniliprole) in 2016.

The influence on *Psylliodes chrysocephala*, *Myzus persicae* and Turnip yellows virus infestation was examined. The results showed that the effectiveness of the neonicotinoid seed treatment depends on the migration time of the imagines of the cabbage stem flea beetle. In 2015/2016 there was no clear effect of the seed treatment on the number of larvae. This might be caused by late migration of the beetles into fields. In contrast in 2016/2017 the imagines migrated early in September and the number of larvae was significantly reduced by Elado. Cyantraniliprole and clothianidin products seem to support crop emergence. Spraying of a pyrethroid (Karate Zeon) in autumn at the right moment decreased the number of larvae in both years. The aphid infestation was only reduced by Elado seed treatment but was less effective in 2016 with high aphid infestation. The virus infection rate was very high in both years and was only slightly reduced by Elado seed treatment.

Monitoring of the UK's 2015/16 neonicotinoid derogation for oilseed rape

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In July 2015, the UK Chemicals Regulation Directorate granted an emergency authorisation for approx. 30 000 ha of neonicotinoid treated oilseed rape seed (Cruiser OSR and Modesto) to be drilled. Their use was confined to four counties at high risk from cabbage stem flea beetle (CSFB; *Psylliodes chrysocephala*). To monitor the impact of this derogation CSFB incidence, damage, resistance to pyrethroids and yield at harvest were assessed in neonicotinoid and non-neonicotinoid seed treated areas in 48 farm crops. Analysis across sites showed that neonicotinoid seed treatments provided protection from adult CSFB feeding damage during crop establishment, with significant increases in plant number at the first assessment (A1; approx. cotyledon to two-leaf stage) and the second assessment (A2; approx. three to four leaf stage), and significant reductions in foliar damage (shot-holes and percent leaf area lost) at A1. Significant increases were observed in the number of adults and larvae in the neonicotinoid compared with the non-neonicotinoid seed treated areas. There was no significant effect of neonicotinoid seed treatment on adult feeding damage at A2, larval scarring or yield at harvest. Analysis of co-factors, undertaken to test whether particular agronomic practices or characteristics of sites were associated with the size of responses to neonicotinoid seed treatment, identified several that added significantly to the explanation of the response variation. Resistance monitoring at harvest found that the percentage of individuals resistant to pyrethroids ranged from 0% to 94% between sites. This presentation will discuss these results in further detail.

Reacting to the threat to the oilseed rape crop from the cabbage stem flea beetles, *Psilliodes chrysocephala*, in the UK, in the absence of neonicotinoid seed treatments

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In autumn 2014 banning of neonicotinoid seed treatments for oilseed rape coincided with high numbers of cabbage stem flea beetles (CSFB) and cool, dry weather conditions which retarded plant development. Grazing damage by adult beetles was extensive, sometimes resulting in complete crop loss, especially in later-sown trials and farm crops. Secondary infestations by beetle larvae, in surviving crops, were a cause for concern for both further crop damage and yield loss and created the potential for very high populations of the pest going forward into the following seasons. The subsequent two sowing seasons have both seen extensive crop damage and losses, with indications that the problem is spreading out, west and north, of the main area of infestation. NIAB has a major interest in field experimentation and variety trialling and is supported by a national membership network of arable stakeholders. To serve our own needs and those of our farmer members we have been developing measures to protect field trials from CSFB, conducted a crowd sourced interactive on-line survey to monitor the problem at the commercial level and novel research into the use of companion cropping. At the small scale, plot level, we have found success with insect monitoring, fine mesh netting to exclude the beetles and with insecticide treated trap cropping around and within trials. The crowd sourced survey has clearly shown the increasing extent of the affected area and interactions with sowing date and agronomic practice. Work with companion species indicates that inter-sowing with white mustard might be beneficial.

Is resistance to insecticides affecting the interaction between aphids and TuYV?

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Oilseed rape is vulnerable to attack by a wide variety of pests in Europe, ranging from slugs to flea beetles, and includes several species of weevils, aphids, pollen beetles and pod midges. Of these, the pest status of peach potato aphid, *Myzus persicae* (Sulzer), is most likely to be affected by the recent ban on neonicotinoid seed treatments that was implemented across the European Union in December 2013, as they attack oilseed rape crops when the seed treatment is still an effective means of controlling this pest. Prior to the ban, neonicotinoid seed treatments gave good control of *M. persicae* infesting oilseed rape in the early stages of development (up to the four-leaf stage), but control in later stages of development was not possible using pyrethroids due to the very high levels of resistance to this group of chemicals. This aphid is rarely abundant enough in autumn on oilseed rape to cause direct damage, but it can cause indirect damage by transmitting Turnip Yellows Virus (TuYV). In recent years, in several European countries, resistance of *M. persicae* to insecticides of different mode of action was identified. In several countries TuYV is the most damaging virus disease of oilseed rape. Therefore, we determined the mechanisms of resistance to insecticides of the different strains of *M. persicae* kept in culture and whether they affect the acquisition and transmission of TuYV. Virus concentration in both plant and vector was determined using quantitative PCR. The feeding behaviour of *M. persicae* on virus-infected and healthy plants was monitored with EPG (Electrical Penetration Graph).

Using dropleg technique during flowering of oilseed rape to avoid pollinator exposure

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Spraying of insecticides and fungicides during the flowering stage of oilseed rape can be necessary to control insect pests (*Ceutorhynchus obstrictus* and *Dasineura brassicae*) and pathogens (*Sclerotinia sclerotiorum*). In contrast to conventional application technique dropleg nozzles are kept below the flowering canopy. This means the exposure of pollinators to active ingredients is reduced and it was demonstrated that chemical residues in honey decreased significantly. The JKI tested the efficacy of different insecticides applied with dropleg technique compared to conventional technique against insect pests in field trials conducted in the area of Braunschweig from 2014-2017. Furthermore in 2017 the effects of the dropleg technique on parasitoids of oilseed rape pests were examined. The crop was treated at full flowering (BBCH 65) with insecticides. After application until harvest adults and larvae of oilseed rape pests were collected using water trays at soil level of each plot. The emergence of new generation beetles was recorded by photoeclectors, ended at BBCH growth stage 78. At least two times during each season oilseed rape plants were cut and the damage caused by *D. brassicae* was examined. The new technique showed similar efficacy compared to conventional spraying technique. This is probably because insect pests also hide in the vegetation layer to shelter against unfavourable weather conditions. Nevertheless pest abundance was not always sufficient to get clear results. In all years yields did not differ significantly regarding the use of conventional or dropleg application technique.

Effects of insecticide applications on population development of pollen beetle in field studies

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Widespread pyrethroid resistance throughout Europe has complicated the control of pollen beetle (*Brassicogethes aeneus*). Insecticides are often required for the effective damage control by overwintered pollen beetles but in addition insecticides can also reduce the reproduction and pest pressure in the next season. The aim of this study was to determine the effects of different insecticides on the population development of pollen beetle. In 2013-2015, field trials were conducted in winter oilseed rape near Braunschweig (northern Germany). Insecticide treated and untreated plots of approximately 1000 m^2 were established in a randomized block design with four replicates. Overwintered pollen beetles were counted before, and several days after insecticide application. In addition buds were collected and dissected to assess the number of eggs and larvae. New generation beetles were sampled using soil-photoeclectors. In addition, greenhouse trials were carried out using untreated and insecticide treated pollen beetles and plants. In all field trials the abundance of overwintered pollen beetles was reduced by Biscaya (a.s. 72 g thiacloprid ha^{-1}) but only up to 7 days after application. The number of buds containing eggs and larvae and the abundance of emerging new generation beetles was significantly reduced in Biscaya treated plots. In all greenhouse trials, the lowest number of infested buds was counted on Biscaya treated plants. The application of Biscaya was suitable for effective damage control by pollen beetles. It could form an important part of a resistance management program by causing lethal effects on pollen beetles as well as effects on egg laying and reproduction.

Current use and development of expert weather-based phenological models for managing oilseed rape pests in autumn and spring

Andreas Johnen presented by Maria Tackenberg

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The web-based decision support system expert incorporates weather-based phenological models for six major oilseed rape pests in Europe: the cabbage stem flea beetle (*Psylliodes chrysocephalus*), the rape stem weevil (*Ceutorhynchus napi*), the cabbage stem weevil (*Ceutorhynchus pallidactylus*), the pollen beetle (*Brassicogethes aeneus*), the cabbage seed weevil (*Ceutorhynchus assimilis*) and the brassica pod midge (*Dasineura brassicae*). The system has been validated and is used by farmers and advisors in several European countries: Germany, the UK, France, Sweden, Austria, Switzerland, the Czech Republic, Poland and the Ukraine. The models predict the start and course of pest immigration (all pests), egg deposition (Stem weevils and Cabbage stem flea beetle) and larval development (Cabbage stem flea beetle) to provide advice on optimal time periods for field and optimal treatment dates. With user's observations of pest density and treatment inputs the system delivers a full control strategy to manage oilseed rape insect pests during the season with field-specific crop protection treatment decisions, selection of suitable chemicals and rates for application and an evaluation of the efficacy of past applications to display protection times. Current projects aim to improve pest observation methods on farm level to differentiate pest risks between and within fields to optimize advice for site specific targeted sprays: tools enabling automated trap assessment will increase the use of traps on farm level and sensors can provide information about in field distribution of pests and non-targets (beneficials and pollinators) to select fields and field areas for sprays to prevent pest damage and to protect beneficials and pollinators.

Identity of parasitoids and their potential for biocontrol of oilseed rape pests in Europe

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The six most important pests of winter oilseed rape are host to ca. 88 species of parasitoids, mostly parasitic Hymenoptera. Among these, eleven species which attack the egg or larval stages of the host have been identified as key parasitoid species of cabbage stem flea beetle (*Tersilochus microgaster*), pollen beetle (*Phradis interstitialis, P. morionellus, Tersilochus heterocerus*), rape stem weevil (*Tersilochus fulvipes*), cabbage stem weevil (*Tersilochus obscurator*), cabbage seed weevil (*Trichomalus perfectus, Mesopolobus morys, Stenomalina gracilis*) and brassica pod midge (*Omphale clypealis, Platygaster subuliformis*). They are sufficiently widespread and abundant across Europe to be of economic importance for natural biological control. Their incidence and abundance in European countries is related to the occurrence of their hosts, thereby indicating close host-parasitoid-relationships. The key parasitoids have potential to significantly reduce pest populations, in many years keeping pest densities below thresholds of economic damage, thereby exerting an important role for the natural regulation of pests. The level of parasitism of major pest species can be determined by dissection of larvae and by rearing the adult parasitoids from their hosts. Percent parasitism of pests varies between countries and years, frequently exceeding 50% and occasionally increasing beyond 80%. Information on the identification, biology, phenology, distribution and possible measures for enhancement of key parasitoid species has been reviewed by Williams (2010)[3] and some of it will be given in this presentation.

[3] Williams, I.H.W. (ed.) (2010) *Biocontrol-based integrated management of oilseed rape pests*. Springer Science+Business Media B.V., ISBN 978-90-481-3982-8.

Long term effects on parasitic wasps of insecticides used to control the pollen beetle

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The effects of several insecticides used to control the pollen beetle in oilseed rape were assessed on parasitic wasps between 2013 and 2015 in field conditions. The products were applied shortly before flowering on large field plots and the populations of parasitic wasps, both at larval and adult stages, were assessed over 6 to 8 weeks, until the end of flowering. According to the effects observed on the parasitism rates and the possible impact on the ratio parasitic wasp/pollen beetle for the next generations, the tested products can be classified in two categories. Pymetrozine, tau-fluvalinate, phosmet and indoxacarb did not reduce this ratio compared to the untreated control and can be used to control the pollen beetle without having negative impacts on natural enemies. Thiacloprid and Chlorpyrifos-ethyl reduced this ratio by 60 to 100% and will probably promote long term development of the pollen beetle populations by severely impacting their natural enemies, despite initial control of the pest. Major differences concerning the date of application of the product, the parasitism rates in the control, the colonization of the field by the parasitic wasps and the delay after the treatment were observed between years but similar results were obtained with the same products during all the experiments. A correlation between the effects observed in these field experiments on pollen beetle parasites and other parasitic wasp species, such as *Aphidius rhopalosiphi*, both in the laboratory and in the field, was also observed.

Can entomopathogenic nematodes contribute to the sustainable management of oilseed rape pest insects?

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Entomopathogenic nematodes (EPN) of the genera *Steinernema* and *Heterorhabditis* are soil dwelling antagonists of insects. The enduring third stage dauer juveniles (DJs) carry specific symbiotic bacteria in their intestine. They invade the host insect and release the symbionts into the haemolymph causing death of the host within 2-3 days. EPN feed on the symbionts and propagate. Once the cadaver is consumed, DJs develop, which leave the insect in search of new victims. EPN are used commercially to control insects in cryptic environments, e.g., weevils in soft fruit, ornamentals and citrus, thrips and leaf miners in greenhouses, sciarids in mushrooms, corn rootworm larvae (*Diabrotica v. virgifera*), codling moth (*Cydia* spp.) and sawflies (*Hoplocampa* spp.) in fruit orchards, flat-headed fruitborer (*Capnodis tenebrionis*) in stone fruit, grubs, tipulids and cutworms in turf. Since mass production surpasses 50 cubic metre scales, EPN are provided at economically competitive prices. Almost all pests in OSR pass some period of their life cycle in the soil and thus are targets for EPN, but surveys usually do not recover EPN from arable crop areas. Results indicate that soil-dwelling stages of flea beetles, pollen beetle larvae, larvae of *Ceutorhynchus* spp. and *Delia radicum* are susceptible to EPN. Attempts to establish nematodes in OSR resulted in increasing population density of the antagonists. EPN cannot be used to prevent direct damage in OSR, but can be used to reduce pest populations over time. The potential of area-wide establishment of antagonistic EPN in OSR rotation will be discussed.

Effects of entomopathogenic nematodes on insect pests of oilseed rape

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Entomopathogenic nematodes are an effective biological control agent against soil insect pests. It is also important to know if they can be used as an IPM tool for insect pests of the crop canopy with soil living life stages. To evaluate the potential of entomopathogenic nematodes as biological control agents against oilseed rape pests field trials were conducted by the Julius-Kühn Institut and the University of Göttingen. Replicated plots each of 720 m² were infested with entomopathogenic nematodes (*Steinernema feltiae*) at BBCH 53-55. At this time the first larvae of *Psylliodes chrysocephala* left the crop plants for pupation in the soil. Nematodes were applied with conventional spraying technique with 500 million nematodes per 0.1 ha and a high water volume of 2862 l ha^{-1}. Soil samples of untreated and nematode treated plots were sampled regularly and colonized with larvae of *Tenebrio molitor* to check nematode infectivity. During the vegetation period population dynamics of oilseed rape pests were monitored by means of water trays at soil level and photoeclectors. Number of larvae of different insect pests in the crop was determined by dissection of plant material and pod examination. The soil samples were infectious until BBCH 80 for *T. molitor* although infestation rate decreased in the end. Nevertheless no effects on larvae in the crop and on the emergence of new generation beetles in the field were observed. In earlier small scale field trials in Göttingen some effects of nematode application on *Brassicogethes aeneus* and *Ceutorhynchus pallidactylus* were detected.

EMPHASIS project: IPM for seedling insects in winter and spring oilseed rape production

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EMPHASIS (Effective Management of Pests and Harmful Alien Species: Integrated Solutions) is an EU project (European Union Horizon 2020 research and innovation programme under grant agreement No 634179) conducted by a consortium of 21 partners from 10 countries. It focuses on native and alien pests(insects, pathogens, weeds) in a range of natural and agro-ecosystems (field crops, protected crops, forestry, etc.). Important plant/pest pathosystems for the EU are studied following a multi-method approach in order to design an IPM methodology. Practical solutions will be assessed, validated and transferred through innovative research and demonstrations to ensure that they are in line with end users' needs and capacities. Seedling insects cause major damage in winter and spring oilseed rape (OSR) production: *Psylliodes chrysocephala*, *Phyllotreta nemorum*, *Delia radicum*, *Agriotes lineatus*, early season aphid (*Myzus persicae*) as a vector of turnip yellows virus (TuYV), and others. Selective insecticides as a seed treatment were an effective way to protect OSR seedlings from insects. The use of insecticide foliar sprays in OSR are less effective, require 2-7 treatments, are more expensive to the farmer, and have higher impacts on the environment. Honey bees and other pollinators are important part of OSR production and the agricultural and forestry sector in general. Careful analyses based on facts and growing practice for all involved stakeholders is required. The purpose of the study is to find IPM methods and technologies for OSR protection against seedling insects in the EU and alternatives for EU farmers to keep the OSR area, yield level and honey bee's sustainability.

IPM4Meligethes ERA-NET project: new approaches to resistance management

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Conventional resistance management for the pollen beetle *Meligethes aeneus* has proven difficult due to the lack of differing modes of action in available insecticides. With the IPM4Meligethes project we wish to develop novel IPM concepts so that chemical pesticides would only seldom be needed. This will reduce the selection pressure, and delay or prevent the development of resistance to pesticides. Key components of our work include: • Cropping system buffering against pest outbreaks • Forecasting, monitoring, and dynamic thresholds • Targeted precision biocontrol • RNA interference methods for *Meligethes aeneus* control • Biosafety and socio-economics of the proposed techniques As the work in the project is in progress, I will here only highlight one aspect to illustrate the complex interrelationships within the cropping system, critically affecting the level of natural control of pollen beetle in Finland. The results of analyzing long-term patterns of country-wide levels of parasitism show that percentage parasitism differs significantly between years and geographical areas. Surprisingly, the percentage parasitism had a strong negative correlation with the severity of aphid attack in cereals, and with the annual sales of dimethoate: in years of severe aphid attack on cereals, populations of pollen beetle parasitoids crash. This appears to prevent effective biocontrol of the pollen beetle, and the build-up of parasitoid populations. In rapeseed, the level of parasitism was not related to the density of host larvae, but correlated negatively with host density in the following year, indicating high potential for natural biocontrol.

Socioeconomics of adopting IPM strategies by oilseed rape farmers

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The concept of integrated pest management (IPM) arose in the 1960s. The adoption rate of IPM in most large-scale field crops in Europe has been low, while in protected crops IPM techniques have gained high acceptance and success. During the EU research project MASTER (2002-2006, Integrated Pest Management Strategies incorporating Bio-Control for European Oilseed Rape Pests) the consortium decided to analyse European OSR growers' perception and knowledge of factors relating to IPM, because IPM as originally understood requires a shift in mind-set in order to design and implement improved IPM strategies. A questionnaire was disseminated to OSR growers in each of the six MASTER partner countries. In total, 1005 replies were obtained for our analysis. The main survey produced 216 responses from Germany, 179 from Finland, 165 from Estonia, 154 from Poland, 136 from Sweden, and 115 from the UK. An additional 40 replies were obtained from pilot studies in Finland and in Estonia. Random postal surveys (Finland, Estonia, UK partly) produced return rates from 25% (UK) to 46 % (Estonia), while targeted surveys provided higher returns: 61 % for Germany, 65 % for Sweden, and 'over 90%' for Poland. Different methods had to be used, because random sampling was possible only in Finland and Estonia, where centralised data on growers are available. Materials and methods, results and discussion of this original MASTER EU survey will be presented in our presentation, and linked to a follow-up study of Finnish OSR growers, which is part of the IPM4Meligethes ERA-NET-project.

An Integrated Pest Management strategy for pollen beetle – are we nearly there yet?

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Pollen beetles are the most abundant insects found in oilseed rape crops during the inflorescence stage. Many populations across Europe are resistant to pyrethroid insecticides and although several alternative active compounds have been registered, IPM tools are more necessary now than ever to help ensure judicious use. Traditional IPM strategies are based on setting thresholds, monitoring, prevention and control. Recent advances in these areas for IPM of pollen beetle will be discussed. Thresholds exist but differ widely between countries across Europe. I will detail recent re-evaluation of the threshold in the UK. On-line decision support systems based on phenological models and driven by weather data can help to focus monitoring effort to when it is most necessary, can help to improve insecticide timing and reduce unnecessary sprays. Monitoring traps are also available to help provide information on local immigration and may potentially replace the need for crop scouting. There are currently no resistant cultivars available, but I will briefly detail recent research in this area and other preventative methods based on crop management. Alternatives to synthetic toxicant insecticides are also largely at the research stage, but sufficient control by natural enemies via conservation biocontrol remains a realistic goal.

Monitoring and IPM of cabbage stem flea beetle in the UK

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Cabbage stem flea beetle (CSFB; *Psylliodes chrysocephala*) is a serious pest of oilseed rape (OSR) in the UK, however chemical control options are limited. A restriction on the use of neonicotinoid seed treatments, which protect OSR seedlings from CSFB damage, came into force in December 2013 and CSFB resistance to pyrethroids, currently the only alternative to seed treatments, was detected in 2014 and is now widespread. In recent years in the UK, several national surveys of adult CSFB damage in the autumn and larval populations in the autumn and spring have been done. In 2014, losses due to adult feeding were estimated at 2.7% of the national crop. Larvae are generally considered to be more damaging than adults and their populations in 2015/16 were the highest recorded for at least twelve years. A further project, investigating integrated pest management (IPM) control strategies, began in 2016. This project aims to provide a better understanding of the impact of different agronomic factors on CSFB damage, whether varieties differ in their susceptibility to CSFB, the inherent tolerance of OSR to CSFB in relation to pest thresholds, the impact of both adults and larvae on yield and the use of trap crops and defoliation for cultural control. Ultimately, the aim is to develop an IPM strategy which farmers/agronomists can use confidently to predict the risk of pest damage and make rational decisions on the need for control measures. This paper reports results from the surveys and presents early results from the IPM project.

Breeding for insect resistance in oilseed rape: is it a dream?

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Dealing with insect pests is one of the biggest challenges facing the cultivation of oilseed rape (*Brassica napus*, OSR). Insect pests are usually controlled using insecticides but the increasing occurrence of insecticide-resistant populations and the socio-economic context argue against the sole use of these substances. Plant resistance is a classical and proven alternative crop protection strategy that is the basic tool of integrated pest management. However, no insect-resistant OSR cultivars are available on the market. Here I review some of the constraints that make phenotyping for insect resistance particularly challenging with OSR and provide perspectives about the development of this resistance. Some studies have shown that breeding OSR for insect resistance could be achieved, and three strategies have been considered: introducing resistance transgenes into the OSR genome, exploiting natural variation in resistance already present in *B. napus* and introgressing resistance from other brassicaceous species. A relative of OSR, white mustard *Sinapis alba*, seems a particularly promising source of resistance against most of the OSR insect pests.

Turnip yellows virus (TuYV) in oilseed rape – multi-annual European monitoring of disease pressure, estimation of yield impact and proposal of a genetic solution

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Turnip yellows virus is a Luteovirus of winter oilseed rape and other crucifers. This viral pathogen is transmitted mainly by *Myzus persicae*, the peach potato aphid. After early infections in September the first symptoms on oilseed rape are visible during late autumn as anthocyanous and red edge discolorations of the leaves. Due to the ban on neonicotinoid seed treatments for oilseed rape in Europe, the young seedlings are no longer protected against aphids. Furthermore, due to the EU agricultural reform and the global climate change the occurrence of TuYV infections in oilseed rape is accelerating. To evaluate the spread of TuYV throughout Europe the seed company Limagrain established an annual monitoring survey since 2015. Sites were sampled in the UK, Denmark, Germany, Austria, France, Belgium, Poland, the Czech Republic, Slovakia, Hungary, Bulgaria, Romania, the Ukraine and Lithuania. Infection levels were measured by DAS-ELISA. Every year, serious infections in the main European oilseed rape cropping areas were found. Finally, the occurrence of TuYV across Europe is much more severe than expected. Reports about a yield impact caused by TuYV infection of up to 47% have been published. The yield performance of conventional and TuYV resistant oilseed rape hybrid cultivars was compared over three years. Based on consequent data mining, it can be stated that severe TuYV infections may cause a yield reduction varying from 5 to 15%. Yield losses caused by virus infections can be avoided by growing a TuYV resistant cultivar.