EIP-AGRI Focus Group

IPM for Brassica

FINAL REPORT
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Summary

This report is the result of the EIP-AGRI Focus Group on IPM (Integrated Pest Management) in Brassica which was launched under the European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI). The Focus Group brought together 20 experts with different backgrounds and experiences (scientists, farmers, advisers…) from across Europe and had the task to:

- identify types of pests and diseases on Brassica in the different EU regions,
- compare methods used in Brassica vegetables and oilseed rape,
- compare existing IPM methods from the point of view of cost-effectiveness,
- list ongoing IPM research and practices,
- identify needs for further research and priorities for innovative actions.

Because a wide variety of Brassica crops are grown around Europe, the EIP-AGRI Focus Group decided to concentrate on winter oilseed rape (OSR) and the three most important Brassica vegetables, cauliflower, broccoli and white cabbage. Beyond the lists of the most important diseases/pests in the various EU Member States, and the inventories of IPM practices, control strategies and bottlenecks per pest/disease (as summarised in the tables in this report), the group came to the following conclusions and recommendations.

Throughout Europe, broadly the same diseases and pests are observed on **oilseed rape**. Problems are caused by soil-borne diseases such as **club root**, **white mould** and **Verticillium wilt** and fungi that survive on plant debris such as **Phoma stem canker** and **light leaf spot**. Their importance is increasing, due to narrow crop rotations (driven by economics) combined with no-tillage practices. The most important pests of OSR that cause problems at the emergence stage and that occur in most OSR producing countries are the **cabbage root fly** and the **cabbage stem flea beetle**, while the **pollen beetle** is a major problem at the flower bud stage. Pests that are not controlled can result in heavy losses. Likewise, control of grass weeds and broad-leaved **weeds** is essential in oilseed rape. Disease control strategies are mainly based on resistant varieties with dominant resistance genes, and fungicides. Recently, the use of neonicotinoid seed treatments has been restricted in Europe, following a new assessment from the European Food Safety Authority. Farmers now rely heavily on insecticide sprays with pyrethroid compounds to control pests. The OSR farmers have no incentive to apply IPM since there are limited market rewards and there is no certification scheme in place. Oilseed rape production faces problems with fungi, insects and weeds that become resistant to pesticides, and fungi that overcome host plant resistance. Moreover, newly emerging diseases and pests pose threats to oilseed rape production throughout Europe.

A wide range of pests and diseases are observed on **Brassica vegetables**, and problems are more specific to certain crops or certain regions. Besides the same soil-borne diseases that occur on oilseed rape, **leaf fungi** impact Brassica vegetables and need to be controlled. Brassica vegetables that are stored can also suffer from **post-harvest diseases**. Insect pests that are problematic on Brassica vegetables throughout Europe include the **cabbage root fly** and a variety of **Lepidoptera**. Oilseed rape serves as a ‘green bridge’ in both space and time for pests and diseases of Brassica vegetable crops, especially in countries with a maritime climate where Brassica vegetables are grown year-round such as the UK. This is clearly reflected in the fact that the same diseases and pests do not pose problems in countries where oilseed rape is not grown in the vicinity of Brassica vegetables. IPM-based strategies are more often used in Brassica vegetables than in oilseed rape, because in vegetable crops farmers are driven towards IPM by markets and certification schemes. Fungicides and insecticides are widely used because they are cost-effective, usually very effective and manageable. The use of broad-spectrum insecticides such as pyrethrins, spinosad and pyrethroids can have serious side effects on parasitoids and natural enemies of insect pests, and causes imbalances in the system if not properly managed. This also occurs in organic farming which allows the use of pyrethrins and spinosad because they are of natural origin.

The use of proper preventive IPM measures could contribute to better management of problems in oilseed rape production. Ideally, European countries should work together on the **development of resistant varieties and exchange information about the dynamics of pathotypes and germplasm** through pre-commercial research activities. When pesticides are used in oilseed rape, their use should be based on reliable, cost-effective and easy-to-handle **decision support systems**. Again, information about systems that work well should be **exchanged at the European level**. Moreover, more research is needed to develop appropriate **application technologies**. **IPM strategies** in oilseed rape such as the use of plant elicitors, biocontrol products, natural

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enemies of pests, and general resistance against pathogens and pests need to be explored. Strategies that work well locally such as mechanical weed control should be shared among different countries. On-farm **demonstration** projects would be useful to show farmers the benefits of IPM in OSR. The same recommendations can be given for Brassica vegetables, but here market demands and certification schemes are already driving farmers towards IPM, although effective alternative non-pesticidal approaches are still limited in number. Efforts should be first concentrated on a few growers which will be leaders in the IPM strategy implementation. Their success will push other growers to follow their example.

Control of pests and diseases in both oilseed rape and Brassica vegetables should be better coordinated at a higher spatial (regional) level as this could lead to long-term strategies resulting in lower overall population levels. This however, requires considerable collaboration between farmers, and incentives are needed to make this happen.

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Introduction

The EIP-AGRI Focus Group (FG) on IPM in Brassica was launched by the European Commission in 2013 as part of the activities carried out under the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI).

The specific topic for this Focus Group was explained as "What cost-effective IPM solutions are there for Brassica? What other solutions can be proposed?" The tasks were further defined:

Taking stock of the state of the art of practice, including a summary of problems and issues:

- identify (types of) pests and diseases relevant for Brassica for different EU regions;
- compare methods between different specialty crops and, particularly, between specialty crops and rapeseed;
- compare existing IPM methods from the point of view of cost-effectiveness.

Taking stock of the state of the art of research, including a summary of possible solutions for the problems listed:

- list ongoing IPM experiments for Brassica;
- list existing IPM practices (including soil-borne) for Brassica and indicate where improvement is needed.

Identifying needs from practice for further research:

- prepare a gap analysis indicating where new solutions need to be found;
- identify priorities for further research actions.

Priorities for innovative actions:

- suggest potential practical Operational Group projects to test new IPM methods for Brassica;
- suggest potential projects of practical Operational Groups and other project formats to test new IPM methods for Brassica.

The members of the Focus Group are listed in **Annex 1**. They served in a personal capacity rather than as representatives of particular organisations.

This report is the result of the findings of the EIP-AGRI Focus Group and serves to inform those who have an interest in developing IPM in Brassica.

Process

The EIP-AGRI Focus Group came together on two occasions. Since important Brassica producing countries such as Spain and Poland were not covered by members of the Focus Group (see Figure 1), the first meeting was organised in Alicante, Spain on 30 and 31 January 2014, and the second meeting in Warsaw, Poland on 27 and 28 May 2014.

Before the first meeting, the experts filled in several tables to collect information about pests and diseases occurring on oilseed rape (OSR) and Brassica vegetables (BV) in Europe, and about existing IPM practices and experiments. Information from some countries that were not covered by the FG members were also added (marked in grey on Figure 1 below). Experts also provided the common names of pests and diseases in different languages (see Annex 2).

The first day of the first meeting was hosted by Agrosum and included a field visit to the production area in Murcia (Torre Pachego), described in Annex 7. During this field visit it was shown that the market plays an important role in getting IPM implemented. Cost and market demands are the most important drivers for farmers when implementing IPM measures.

All participants contributed to the wide inventory of pests and diseases for the different Brassica crops, being both OSR rape and vegetables, for different regions. The experts worked together in small groups to complete the information in the tables prepared on the basis of the homework. Methods used in oilseed rape were

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compared with the control strategies used in Brassica vegetables. It became clear that it is very difficult to compare existing IPM methods from the point of view of cost-effectiveness, because cost is not the only parameter that determines whether a control strategy will be used or not. Other parameters such as convenience of use or whether the strategy solves a technical problem also need to be taken into account.

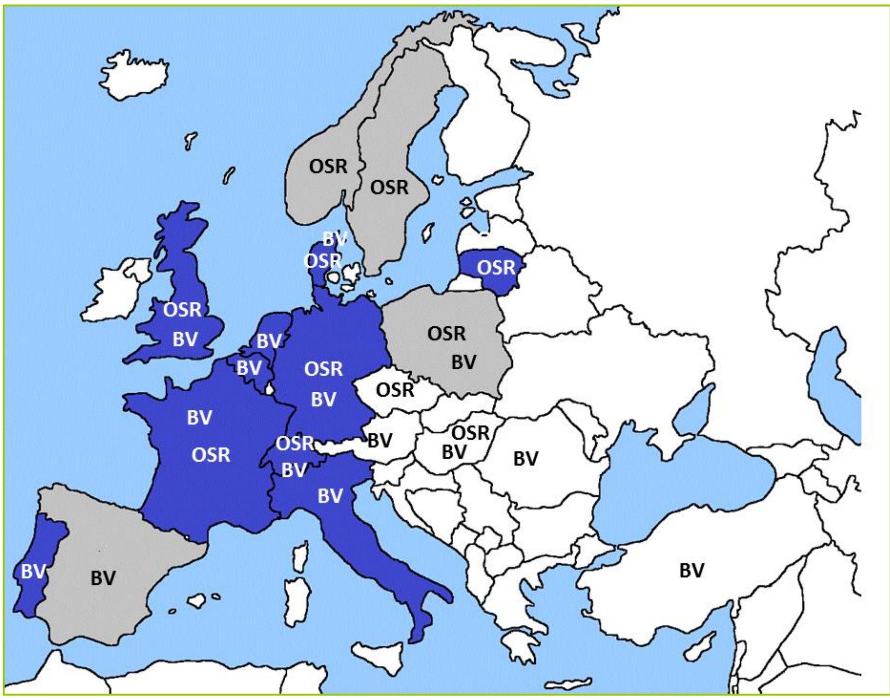

Figure 1. Major oilseed rape (OSR) and Brassica vegetable (BV) producing countries in Europe. In blue: countries covered by EIP-AGRI Focus Group members. In grey: countries for which additional information was collected.

During the second meeting, invited speaker Professor Josef Robak from the Research Institute of Horticulture in Skiernewice, Poland, introduced the situation of IPM implementation in his country. Mr. Brinks, member of the Focus Group, gave a presentation on the role of certification in IPM implementation. Mr. Luc Peeters, also a member of the Focus Group, made a presentation about the pest management situation in minor uses and specialty crops. During the first breakout session experts revised and improved information, based on the homework, on key and secondary pests and diseases for Brassica vegetables (with a focus on white cabbage, cauliflower and broccoli) and for oilseed rape. During the second session current strategies, listed IPM alternatives and bottlenecks were checked and the information was completed. In the third breakout session experts discussed and completed the inventory of ongoing research based on bottlenecks (either generally, or specifically for one pest or disease) and made suggestions for further research.

Breakout sessions were carried out in two parallel groups: pests of Brassica vegetables and OSR, and diseases/weeds of Brassica vegetables and OSR.

This report is based on the inputs from the homework, breakout sessions and presentations during the meetings.

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Brassica species

Economically important Brassica species can be divided into Brassica vegetables, which predominantly belong to the species *B. oleraceae* and *B. rapa*, and the *Brassica* oilseeds, which belong to the species *B. napus* and *B. rapa*.

The origin of the different Brassica species and the most important Brassica vegetables and oilseeds grown in Europe are listed in **Annex 3**. The major producing countries are shown on Figure 1 above. Brassica oilseeds (predominantly *B. napus)* are produced on more than 6 million ha in Europe. The major producing countries are Germany, France, Poland and the United Kingdom (UK). Turnip rape (*B. rapa*) is mainly grown in Estonia, Latvia, Lithuania, Poland, Scandinavia and in the UK. Brassica vegetables (predominantly *B. oleracea)* are produced on about 430,000 ha in Europe. More than half of this is situated in Eastern Europe. The most important Brassica vegetables are cauliflower, broccoli and white cabbage. France is the main cauliflower producer, while Spain is the most important broccoli producer. White cabbage is the most important Brassica vegetable in Eastern Europe with Hungary, Romania and Poland as major producing countries.

The experts decided to focus the discussion on IPM in Brassica on oilseed rape (*B. napus*) and on the following Brassica vegetables: white cabbage, cauliflower and broccoli.

Integrated pest management

The Directive 2009/128/EC on sustainable use of pesticides provides a definition of IPM. Integrated pest management is a broad-based approach. It means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms. These measures also encourage the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment.

Integrated pest management emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems, and encourages natural pest control mechanisms[1]. A pest is any organism that damages or interferes with the crop plants. It can be a weed, an invertebrate (insects, mites, slugs, nematodes), a bird, rodent or other mammal, or a pathogenic microorganism (fungi, bacteria, viruses).

IPM is based on accurate pest identification which is now more reliable with the molecular tools that are available. It typically includes regular observation, crop monitoring and applying economic damage thresholds to determine if, when and what treatments are needed for effective control. Emphasis is given to preventive measures (for instance cultural practices, the use of pest-free and pathogen-free planting material, the use of resistant varieties, supporting functional biodiversity) to suppress or prevent pests. They should be exploited to the fullest extent to reduce the need for direct control measures.

Direct measures should only be taken if they are economically justified. Preference is given to non-chemical control measures such as physical interference (nets or traps, mechanical weed control) and biological control (the use of natural enemies – predators, parasites, pathogens, and competitors – to control pests and their damage) if they provide satisfactory pest control.

Chemical control is only used when needed. Pesticides should be selected and applied in a way that minimises their possible harm to people and to the environment. Resistance management strategies are applied to prevent the development of resistance in pests, pathogens or weeds. The general principles of integrated pest management as formulated by the European Union can be found in **Annex III of the Directive 2009/128/EC.**

[1] DIRECTIVE 2009/128/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides.

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Diseases of oilseed rape and Brassica vegetables

State of play

Oilseed rape (OSR)

Major diseases on OSR (Figure 2) are soil-borne (clubroot, Sclerotinia white mould and Verticillium wilt) or survive on crop debris in the soil (Phoma stem canker, light leaf spot). The growing importance of these diseases can be attributed to increases in the area of OSR, narrow crop rotations and changes in cultural practices such as a tendency towards no-tillage. The occurrence of these diseases in different European countries is listed in Annex 4. Clubroot caused by *Plasmodiophora brassicae* is considered a key disease on oilseed rape in all producing countries, and is becoming more widespread. Other important and widespread diseases are Phoma stem canker caused by *Leptosphaeria maculans*, wilt disease caused by *Verticillium longisporum* and white mould caused by *Sclerotinia sclerotiorum*. Light leaf spot caused by *Pyrenopeziza brassicae* is a key disease in the UK, while most other countries do not report problems with this pathogen. The reason for this is not clear, but it could be due to favourable climatological conditions. Problems with Turnip yellows virus are mainly reported in the UK, Sweden and Denmark. This virus is transmitted by a wide range of aphids including *Myzus persicae* and *Brevicoryne brassicae*.

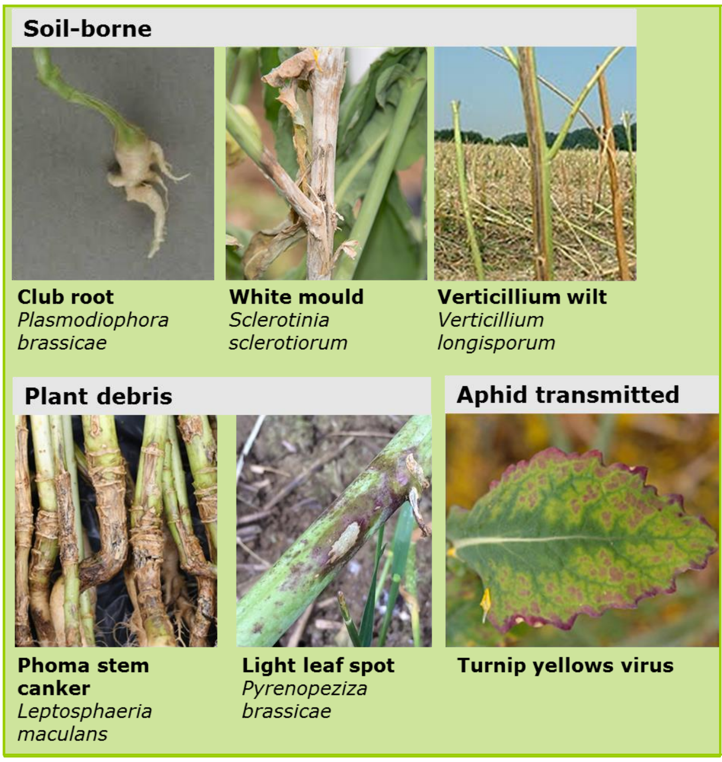

Figure 2. Most important diseases on oilseed rape in Europe

Other emerging diseases which appear to be linked to close rotations and which have so far only been reported in the UK are white leaf spot, caused by *Pseudocercosporella capsellae*, a fungus that also survives on crop debris, and *Olpidium brassicae*, a soil-borne fungus that has an impact on OSR yield at high concentrations. *Alternaria* diseases are rarely an issue on OSR, but it should be noted that OSR can be a reservoir for *Alternaria*, which can cause problems in Brassica vegetables.

Control strategies that are currently used, and additional IPM methods are summarised in Table 1, while further details can be found in Annex 5. They are mainly based on cultural practices such as crop rotation and the removal of infected debris, the use of resistant varieties, and fungicide sprays which are only in some cases based on forecasting systems. *Plasmodiophora brassicae* is controlled by longer crop rotation, liming and resistant varieties. No chemical control strategy is available.

Table 1. Diseases of oilseed rape: control strategies and bottlenecks

Latin names	EPPO code[1]	Control strategies currently used	Additional IPM methods	Bottlenecks
Fungi				
Plasmodiophora brassicae	**PLADBR**	crop rotation and late sowing, liming, resistant varieties, boron	Same as current strategies	resistant varieties may be lower-yielding, resistance not stable, land use (much of the land is rented), monitoring services costly, sampling strategies problematic, conflict between weed management and disease management, no registered fungicides (won't be approved in near future)
Sclerotinia sclerotiorum	**SCLESC**	crop rotation, ploughing, removal of infected debris, disease forecasting, fungicides	biological control, disease forecasting	rotation not easy, no resistant varieties, wide host range, risk for fungicide resistance, biological control is expensive and complicated but can contribute to control in combination with other measures, challenge to develop monitoring and disease forecasting, forecasting system works in the UK but leads to many sprays, other forecasting systems are not reliable enough; challenge to have EU-wide initiative to improve forecasting and decision support sytems
Verticilllium longisporum	**VERTLO**	crop rotation and healthy seed, no tillage, organic matter management, partial resistant varieties	biological control	no good resistance available, no chemicals available, biological control in research stage

[1] EPPO codes are computer codes developed for plants, pests (including pathogens) which are important in agriculture and plant protection. This harmonised coding system aims to facilitate the management of plant and pest names in computerised databases, as well as to facilitate the data exchange between IT systems. EPPO codes can be freely downloaded and incorporated into other IT systems.

Leptosphaeria maculans (Phoma lingam)	**LEPTMA**	crop rotation, removal of infected debris, resistant varieties, disease forecasting, fungicides	soil tillage, spore trapping	farmers prefer minimal tillage; limited range of resistant varieties; pathogen adaptation to host resistance; no specific resistances left (RLM7 is last one)
Pyrenopeziza brassicae	**PYRPBD**	crop rotation, removal of infected debris, resistant varieties, fungicides	soil tillage, rotations and ploughing	farmers prefer minimal tillage, fungicide resistance serious problem in UK, limited number of varieties with good resistance, yield penalty, resistance unstable, increased disease pressure means an increase in sprays
Viruses				
Beet western yellows (= Turnip yellows virus)	**TUMV00**	insecticides to target vector	time of sowing, resistant varieties	neonicotinoid ban has increased foliar insecticide use, insect vectors resistant to pyrethroids, resistance could come with yield penalty, only one resistant variety available

Leptosphaeria maculans and *Pyrenopeziza brassicae* are controlled by resistant varieties in combination with fungicide sprays during leaf production. *Sclerotinia sclerotiorum* is mainly controlled by fungicide sprays during flowering. No good control strategy exists for *Verticillium longisporum*. Viruses are controlled by targeting the aphid vector with insecticides. In organic farming, most OSR diseases are sufficiently controlled by a 5-7 year crop rotation with grass clover and cereals as the main crops. In addition, infected debris and volunteer OSR plants are removed.

Brassica vegetables

In contrast to OSR there are large differences in key diseases of Brassica vegetables in the different countries. In addition, some diseases are very specific for one crop or one country, which makes it more difficult to draw general conclusions (**Annex 4**). An overview of the most important diseases of Brassica vegetables is given in Figure 3.

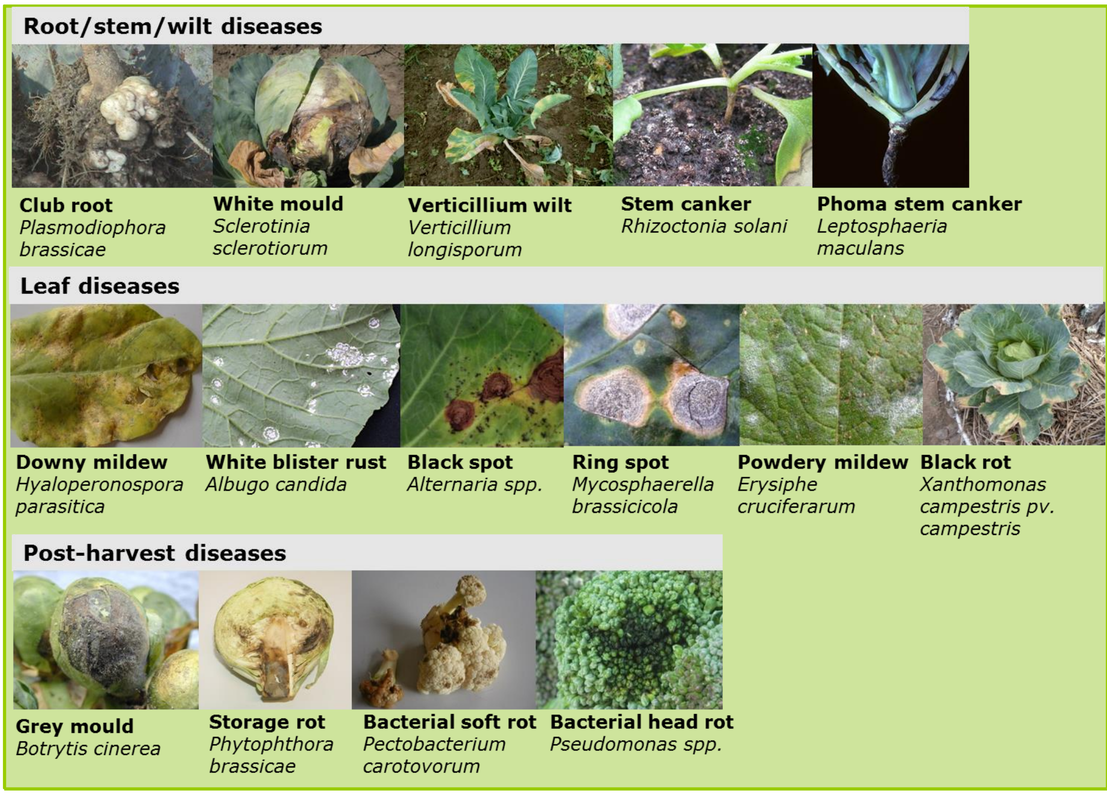

Figure 3. Most important diseases of Brassica vegetables in Europe

Soil-borne diseases on Brassica vegetables include club root, white mould, Verticillium wilt, stem canker and ring spot disease. Club root is a key problem in most European countries; Verticillium wilt only occurs on cauliflower. Besides soil-borne diseases, leaf pathogens and post-harvest pathogens can be problematic on Brassica vegetables. Downy mildew caused by *Hyaloperonospora* mainly causes problems in nurseries. White blister rust causes problems on cabbage in the Netherlands and Belgium. Other leaf pathogens that are reported to be problematic on broccoli, cauliflower and cabbage in more than one European country include the fungal leaf pathogens *Alternaria* and *Mycosphaerella* and the bacterial pathogen *Xanthomonas campestris* pv. *campestris*. *Alternaria* is particularly harmful in Italy, Spain and Portugal. *Mycosphaerella* is the number one disease on cauliflower in France. Black rot caused by *Xanthomonas campestris* pv. *campestris* is problematic in various European countries, but not in France. As stated above, the vicinity of OSR to vegetable fields can cause increasing problems with *Alternaria* on the Brassica vegetables. Post-harvest diseases such as grey mould, *Phytophthora* storage rot and bacterial head rot and soft rot can cause problems in some countries such as Belgium and the Netherlands. Some diseases are problematic, such as virus diseases in the UK and *Stemphylium*

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in Portugal. *Pyrenopeziza* is an emerging problem. A new disease reported on cabbage in Poland is *Fusarium avenaceum*.

A summary of control strategies is given in Table 2, while further details can be found in **Annex 5**. In comparison to OSR, a larger variety of control strategies are applied to Brassica vegetables. In greenhouses and nurseries, soil steaming and disinfection measures are used to control pathogens such as *Plasmodiophora brassicae*, *Sclerotinia sclerotiorum* and *Leptosphaeria maculans*. Disease-free seeds are important to avoid problems with *Hyaloperonospora parasitica*, *Alternaria* spp., *Leptosphaeria maculans* and *Xanthomonas campestris* pv. *campestris.* Leaf pathogens such as *Hyaloperonospora*, *Albugo*, *Alternaria*, *Mycosphaerella* and *Erysiphe* are controlled by resistance varieties, when available, and by fungicides. Biocontrol is at the moment only regularly applied against soil-borne pathogens such as *Sclerotinia and Rhizoctonia* but is in development for other pathogens. Problems with post-harvest pathogens can be reduced with cultural practices. Only healthy plants should be stored. Plant viruses are controlled by cultural practices, by eliminating cruciferous weeds and controlling the aphid vectors.

In organic farming, cultural practices are the most important basis for disease control. They include a four-year crop rotation, removal of infected debris, control of Brassica weeds, no use of green manures or intercropping with Brassica species, hygiene/sanitation measures, and the use of healthy certified seeds.

Bottlenecks

OSR (Table 1)

Cultural practices

It is clear that narrow crop rotations and no-tillage lead to increasing problems with soil-borne pathogens and fungi that survive on crop debris. This includes newly emerging pathogens such as *Olpidium brassicae* that are poorly understood. Crop rotation in conventional OSR is not easy because there is an economic drive towards short rotations. In addition, farmers often prefer minimal tillage because this requires less labour and fuel and saves time. Moreover in OSR there is clearly a conflict of strategies within short rotations. While no-tillage is recommended to avoid the spread of clubroot on the field itself, or between fields, this increases problems with other diseases that survive on infected debris such as Phoma stem canker and light leaf spot.

Resistant varieties

OSR cultivars have only low levels of resistance to Verticillium wilt. This is probably due to the fact that this is an emerging disease which has only recently received attention from breeders. There is no satisfactory resistance to Sclerotinia white mould in any Brassica cultivar. For Phoma stem canker and early Phoma leaf spot huge progress has been made in the development of high-yielding resistant varieties. For clubroot however, only a limited number of resistant varieties are available. These are often lower-yielding, and resistance is not stable because the pathogens adapt to the host resistance. To identify new sources of host resistance, the pathogenicity in the pathogens needs to be monitored, and standard differential lines of OSR need to become available.

Monitoring and disease forecasting

Sampling and monitoring of *Plasmodiophora brassicae* is not easy and is costly. Forecasting systems for *Sclerotinia sclerotiorum* have been developed but they are often not reliable, which can lead to an increased use of fungicide sprays.

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Table 2. Diseases on Brassica vegetables: control strategies and bottlenecks

Latin names	EPPO code	Control strategies currently used	Additional IPM methods	Bottlenecks
Fungi				
Plasmodiophora brassicae	**PLADBR**	crop rotation, liming, balanced fertilisation, soil steaming and disinfection in greenhouses, resistant varieties	soil indexing, biological control	resistance likely to break down; monitoring may be costly; resistance not stable, biological control in research stage
Sclerotinia sclerotiorum	**SCLESC**	crop rotation, soil steaming and desinfection in greenhouses, disease forecasting, fungicides, biological control		soil steaming and disinfection very expensive, biocontrol extra cost; fungicides need to be used with forecasting; no host resistance; risk of fungicide resistance
Verticillium longisporum	**VERTLO**	crop rotation	biological control	biological control in research stage, no resistant varieties available, but varieties can differ in susceptibility
Rhizoctonia solani	**RHIZSO**	crop rotation, removal of infected debris, seed treatments with fungicides, glasshouse seedlings, biological control	biofumigation	biofumigation and biocontrol expensive
Leptosphaeria maculans (Phoma lingam)	**LEPTMA**	disease-free seeds, crop rotation, soil tillage, green manure, fungicides, biological control		tillage is costly, only partial solution, biocontrol only partial solution at best; fungicides used for other foliar pathogens will have effect on Phoma
Pyrenopeziza brassicae	**PYRPBR**	crop rotation, soil tillage, removal of infected debris, fungicides, resistant varieties		limited information about resistant varieties and variability in pathogen, ploughing is costly; fungicide resistance problems

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Latin names	EPPO code	Control strategies currently used	Additional IPM methods	Bottlenecks
Hyaloperonospora parasitica (Peronospora parasitica)	**PEROPA**	crop rotation, soil steaming and desinfection in greenhouses, disease-free seeds, ventilation, irrigation, fungicides in raising houses, resistance	biofumigant seed meals, vegetable oils, biocontrol, resistant varieties, synthetic elicitors	new biocontrol products costly and efficacy may be partial (one product under registration); resistance is used in marketing of cultivars but unverified and no good decision support system for growers
Albugo candida	**ALBUCA**	crop rotation, hygiene, resistant varieties, fungicides		cultural practices not effective, not convenient, resistance only partial and variety choice limited
Alternaria brassicae and brassicola	**ALTEBRA**	disease-free seeds, crop rotation, forecasting, chemical treatment, resistance		resistance available?; changing growing practices not convenient; Fungicides are effective and solve problem, should be used in conjunction with forecasting
Mycosphaerella brassicicola	**MYCOBR**	crop rotation, forecasting, fungicides, resistance	cultural practices	fungicides are effective and should be used in conjunction with forecasting; resistance only partial; DSS services may be costly; unknown resistance backgrounds may mean that resistance breaks down sooner, resistance in Brussels sprouts is limited
Erysiphe cruciferarum	**ERYSCR**	resistant varieties, fungicides	vegetable oils, biofumigant seed meals, biopesticides	fungicides are effective, limited number of partial resistant varieties; new products only partially effective and require extra effort from grower, biopesticides in research stage
Phytophthora brassicae	**PHYTBR**	crop rotation, avoid excess N, improve drainage, avoid wet harvest conditions		mainly a problem in storage, chemical control is not very effective
Botrytis cinerea	**BOTRCI**	hygiene, avoid excess N and physical damage to crop, only healthy plants should be stored		mainly a problem in storage

Latin names	EPPO code	Control strategies currently used	Additional IPM methods	Bottlenecks
Bacteria				
Xanthomonas campestris pv. campestris	**XANTCA**	hygiene, crop rotation, soil steaming and disinfection in greenhouses, disease-free seeds, irrigation control, resistance	biological control, monitoring, resistant varieties	resistant varieties unknown or may not be stable (and therefore not suitable for marketing); Soil steaming and hot water treatment very expensive, cultural practices do not solve the problem; very difficult to produce disease-free seeds; biocontrol with bacteriophages in research stage
***Pectobacterium carotovorum* soft rot**	**ERWICA**	avoid excess N, avoid injury to crop at harvest, store only healthy plants		mainly a storage problem
Pseudomonas fluorescens* and *viridiflava	**PSDMFL**	avoid excess N, avoid injury to crop at harvest, drip irrigation, avoid wetter fields; partial resistance for broccoli, copper and CaCl2		very difficult to control and only partial resistance
Viruses				
Cauliflower mosaic virus	**CAMV00**	crop rotation and removal debris; avoid close planting, resistant varieties, control of aphid vectors	resistant varieties, destruction of plant material and weeds	cultural practices will constrain growing practices in some situations, resistant varieties limited in availability; destruction extra work for grower and not fully effective
Turnip mosaic virus	**TUMV00**			
Beet western yellows = Turnip yellows virus	**BWYV00**			

Chemical control

Fungicides are used to control Sclerotinia white mould, Phoma stem canker and light leaf spot. Increased disease pressure, however, leads to an increased use of sprays, and pathogens adapting easily and becoming resistant. Fungicide resistance is already a major problem in the UK, especially for *Sclerotinia* and *Pyrenopeziza* and it is likely to increase in other European countries. No chemicals or registered fungicides are available to control club root or Verticillium wilt. Soil steaming or fumigation is required to destroy their survival structures but this is not an economic option in large fields.

Non-chemical plant protection strategies

Biological control is available for *Sclerotinia sclerotiorum*. It is based on the use of *Coniothyrium minitans*, a parasite of the survival structures of this fungus. This strategy is not widely used by farmers because the product is considered to be too expensive and too complicated to apply, and it requires a long-term approach to reduce inoculum levels in the soil. For other diseases, no biological control strategies have been developed.

Brassica vegetables (Table 2)

Cultural practices

Cultural practices such as tillage are considered to be inconvenient, or too costly and ineffective in the short term. Multiple cropping systems, which are typical in many countries, and crop rotations can both suppress diseases. However, when applying a crop that can serve as a host plant for diseases, this will have an opposite effect.

Resistant varieties

If resistance is available it is often only partial, and the choice of varieties is limited. Resistance is used to market cultivars, but is often unverified. For some vegetables resistant varieties are only locally available. In Brittany (France), locally grown cultivars of Brassica vegetables show resistance towards local strains of *Xanthomonas campestris* pv. *campestris*.

For pathogens such as *Plasmodiophora*, resistance is likely to break down. Pathotype monitoring is done locally, but is not coordinated at the European level.

Monitoring and disease forecasting

Decision support systems that could reduce the use of fungicides may be costly when available.

Chemical control

Current control strategies such as the use of fungicides are cost-effective, manageable and work very well. This means that there is no incentive for farmers to implement more expensive strategies such as biocontrol, which can be less effective. Fungicide resistance problems have mainly been reported for *Pyrenopeziza* in the UK and for *Sclerotinia*, two pathogens that also occur on OSR.

It should be noted that for some minor Brassica crops, registration of fungicides is problematic because the market is small.

Alternative plant protection strategies

Biocontrol products are considered to be too expensive and are at best only partially effective. An elicitor based on ASM (Acibenzolar-S-Methyl) has been registered in France, to be used against downy mildew on cauliflower. It shows a good efficiency on plantlets. Soil steaming and disinfection are very expensive and can only be used for vegetables that are grown in greenhouses.

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Overview of research – missing implementation – missing testing – missing research

OSR

Research on diseases of oilseed rape, especially on resistance breeding, is mainly done by the private sector. This means that there is only limited or even no access to the research information. Monitoring of pathogens is mainly done at the national level and is not internationally coordinated. There are local initiatives to develop decision support systems and disease forecasting but again there is no international coordination. A large international consortium is working on a GMO approach to control *Sclerotinia sclerotiorum*. There is no holistic approach to control pathogens in oilseed rape that are associated with soil-borne and plant debris, and some of the newly emerging diseases are poorly understood.

Brassica vegetables

In several countries there is ongoing research about disease resistance for pathogens such as *Hyaloperonospora* and *Mycosphaerella,* but there is no coordination at the European level. Resistance breeding is often done by seed companies. Research about disease forecasting for *Sclerotinia* and fungal diseases of Brassica vegetables is ongoing in the UK. Research about alternative products, including biocontrol, is carried out at the local level. Seed testing techniques for *Xanthomonas* are being improved in a European project.

Pests of oilseed rape and Brassica vegetables

State of play

OSR

The most important pests of OSR are presented in Figure 4. Pests that cause problems at the emergence stage are the cabbage root fly (*Delia radicum*), flea beetles (*Phyllotreta* spp.), the cabbage stem flea beetle (*Psylloides crysocephala*) and the cabbage stem weevil (*Ceutorhynchus pallidactylus*). The cabbage root fly and cabbage stem flea beetle occur in most OSR producing countries (see **Annex 4**). The pollen beetle (*Meligethes aeneus*) is a major problem at the flower bud stage. Problems with insects are increasing in regions with increased OSR production. The Wessex flea beetle *Psylliodes luteola* is only a problem in the UK. Slug problems are already serious in the UK and they are gaining importance in other areas. Cyst nematodes have only been reported to be problematic in the UK. They are probably linked to narrow crop rotations. Wild life damage, mainly due to pigeons, is a problem in large fields in the UK and in Germany.

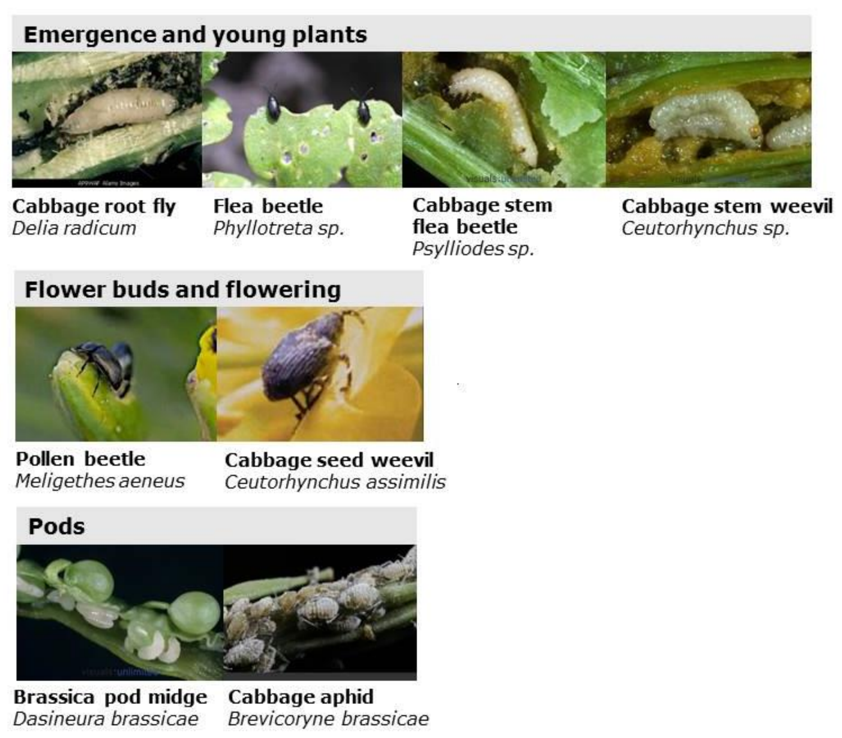

Figure 4. Important pests of OSR in Europe

Control strategies for pests of OSR are listed in Table 3. In conventional farming, pests of OSR are typically controlled by insecticides. Until recently, neonicotinoid seed treatments were regularly applied, but their use has been restricted in Europe following a new assessment from the European Food Safety Authority[1]. Foliar sprays are dominated by pyrethroid compounds. Slugs are controlled by molluscides, methaldehyde and ferric phosphate. In organic OSR production, emergence stage pests are diminished by early sowing. Silica rock dust is applied to avoid feeding damage by the cabbage stem flea beetle. Slug damage is reduced by avoiding to sow under moist conditions and through higher sowing densities at the borders of the field. Ferric phosphate pellets are also used. Damage by the pollen beetle is reduced by choosing early flowering varieties and by applying silica rock dusts.

[1] Commission Implementing Regulation (EU) No 485/2013.

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Table 3: Pests of OSR: control strategies and bottlenecks

Latin name	EPPO code	Control practice currently used	Additional IPM methods	Bottlenecks
Delia radicum	**HYLERA**	insecticides, until recently seed treatment	cultural practices, decision support systems	decision support systems: species' determination is difficult, some regions with high competiveness of OSR risk high losses without chemical control
Pyllotreta spp.	**PHYLSP**	insecticides, until recently seed treatment	avoid proximity to Brassica	not possible to avoid proximity to Brassica in arable areas; some regions with high competiveness of OSR risk high losses without chemical control
Psylliodes chrysocephala	**PSYLCH**	insecticides, until recently seed treatment	avoid proximity to Brassica, yellow traps, vegetable oils, silicate rock dust	yellow traps don't work; vegetable oils are not effective; not possible to avoid Brassica in arable areas; some regions with high competiveness of OSR risk high losses without chemical control; pyrethroid resistance
Ceutorhynchus pallidactylus	**CEUTQU**	insecticides	cultural practices, decision support systems	visual control of oviposition holes is difficult and labour-intensive
Ceutorhynchus napi	**CEUTPI**	insecticides	cultural practices, decision support systems, resistance	visual control of oviposition holes is difficult and labour-intensive; more information needed about resistance; in some regions high losses without chemical control
Ceutorhynchus assimilis	**CEUTAS**	insecticides	cultural practices	insecticides used for other targets may give some control
Dasineura brassica	**DASYBR**	insecticides	cultural practices	usually side effects of other treatments are sufficient; in regions with high competiveness of OSR high losses without chemical control
Meligethes aeneus (renamed Brassicogethes)	**MELIAE**	insecticides	density of rape production, trap crops, decision support systems, early flowering	trap crops usually not reliable; DSS: thresholds not linked to yield; silicate rock dust less efficient and more expensive; insecticide-resistant beetles; early flowering varieties not reliable and yields may be compromised by late frost

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Latin name	EPPO code	Control practice currently used	Additional IPM methods	Bottlenecks
			varieties, silicate rock dust	
slugs and snails		snail baits, molluscides, methaldehyde, ferric phosphate	cultural practices, biocontrol	biocontrol too expensive and efficacy data lacking in arable situation; ferric phosphate more expensive than metaldehyde, slug problem becoming worse, applications limited; no good thresholds
wild life damage		avoiding risky areas, pigeon shooting	repellent seed treatment	problem in large fields; pigeon pressure can be very high, shooting cannot cope; nets, fences, shooting, etc. too expensive; repellent seed treatment not available

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Brassica vegetables

Pests that are specifically problematic on Brassica vegetables are illustrated in Figure 4. Their distribution in Europe is given in **Annex 4**. The most important Brassica pests of broccoli, cauliflower and white cabbage in all producing countries are the cabbage root fly (*Delia radicum*), the cabbage aphid (*Brevicoryne brassicae*) and a variety of Lepidoptera such as the silver Y moth (*Autographa gamma*), the cabbage moth (*Mamestra brassicae*) and the diamond black moth (*Plutella xylostella*), the small white butterfly (*Pieris rapae*) and the large white butterfly (*Pieris brassicae*). The beet army worm (*Spodoptera exigua)* and the cotton leaf worm (*Spodoptera littoralis)* have been reported in Southern countries such as Spain, Italy and Portugal. Some pests are only problematic on specific Brassica crops. For instance, Cabbage whitefly (*Aleyrodes proletella)* is becoming a big problem in Brussels sprouts and in kale crops in Germany, the UK and Switzerland, while flea beetles *Phyllotreta* spp. are becoming problematic in swede, rocket and radish. Thrips are mainly problematic on white cabbage. In addition, typical OSR pests such as the pollen beetle (*Meligethes aeneus*) are causing problems in Brassica vegetables in Germany, the UK and Switzerland, where OSR is grown in the vicinity of Brassica vegetables. OSR is also a source of infestations of cabbage root fly and cabbage whitefly, allowing populations to build up. Some pests, such as the cabbage root fly, are more prominent in organic farming than in conventional agriculture. Nematodes are considered as secondary pests or they do not cause problems, except for *Meloidogyne* in Italy. Slugs are a big problem on all Brassica vegetables. Wild life damage, mainly by pigeons, is a problem on seedlings in particular.

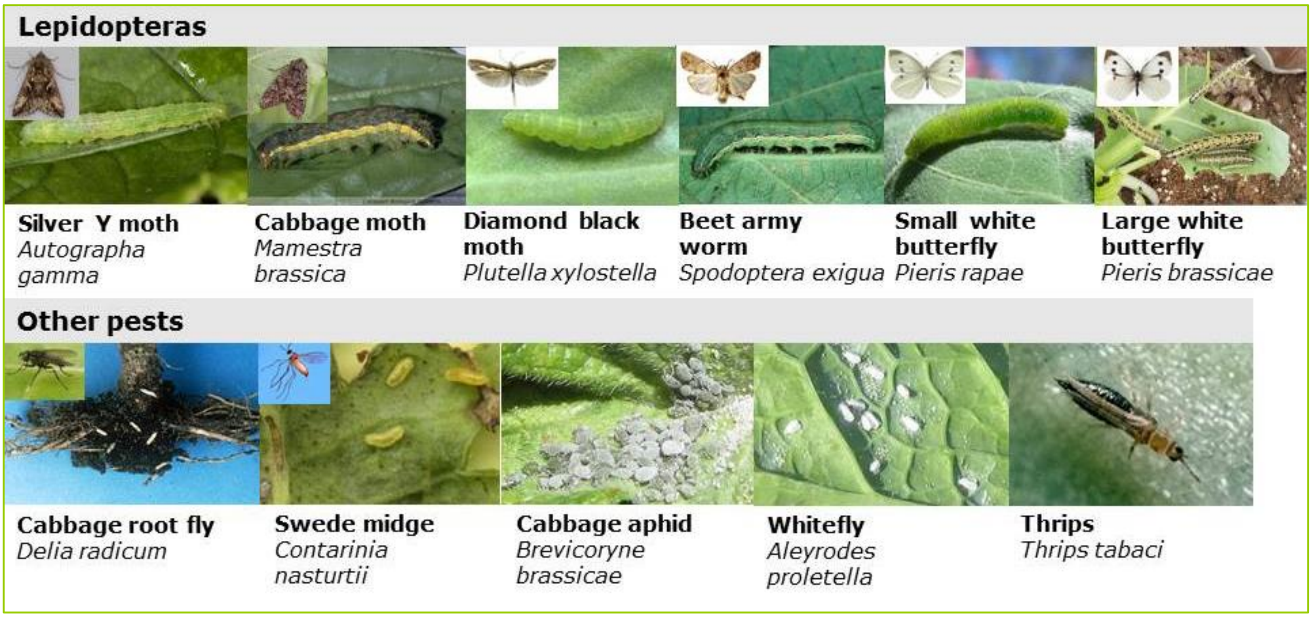

Figure 4. Important Brassica pests in Europe

Table 4. Pests on Brassica vegetables: Control strategies and bottlenecks

Insects	EPPO code	Control strategies currently used	Additional IPM methods	Bottlenecks
Delia radicum	**HYLERA**	nets, insecticides, seed treatment, drench treatment, sprays; monitoring and forecasting		problem in organic crops, disperses further than 1 km, conservation control insufficient; DSS doesn't have much impact since most effective treatments are prophylactic; insecticides have side effects on beneficials; few good working insecticides available; nets create other problems with pests and diseases
Lepidopteras		Insecticide sprays and Bacillus thuringiensis; monitoring	decision support systems	biological control needs precise timing to be effective, biocontrol more expensive and less effective, growers need to be encouraged to use alternatives to pyrethroids and other broad-spectrum insecticides; insecticide resistance in Plutella; Plutella disperses over great distances; OSR is another host
Myzus persicae	**MYZUPE**	insecticides, seed treatments and sprays; monitoring and forecasting, suction traps, vegetable oils, soaps	reducing N input, suction traps	insecticide resistance, reduction of natural enemies, main challenge is insecticide resistance management; reducing N input is not feasible
Brevicoryne brassicae	**BRVBR**	insecticides, seed treatments and sprays; monitoring and forecasting, suction traps, vegetable oils, soaps	functional biodiversity	difficult to control with contact insecticides; often heavily parasitised by parasitoids and predators if not disturbed by insecticide use
Contarinia nasturtii	**CONTNA**	monitoring, cultural practices, chemicals; field distance; seed treatments		expertise required to separate out the midges from other insects in traps; not enough information on control methods and treatment timing
Aleyrodes proletella	**ALEUPR**	insecticides, sprays, seed treatments	cultural practices, nets	some insecticides not very effective; exclusion of parasitoids with nets sometimes worsens the situation; resistance to pyrethroids

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Insects	EPPO code	Control strategies currently used	Additional IPM methods	Bottlenecks
Thrips tabaci	**THRITB**	tolerance in some white and red cabbage varieties, occasionally insecticides, often no control, spinosad	DSS (French model), tolerant varieties, vegetable oils; spraying techniques	vegetable oils may not be effective, systemic insecticides needed, tolerant varieties not wanted by commercial growers; anything that would help target treatments would be good since it is difficult to find correct application time and subsequently efficacy of insecticides is often poor
***Phyllotreta* spp.**	**PHYLSP**	cultural practices, insecticides, nets	distance to other cabbage fields, silicate rock dust	hard to separate fields
Meligethes aeneus	**MELIAE**	no control or insecticides when in neighbourhood of OSR, nets, DSS	trap crops, nets	trap crops and nets are not worth the extra management cost because sporadic pest; forecasting model of summer flight urgently needed; adults need to be controlled on cauliflower and broccoli; problems with pre-harvest interval
Agriotes/Hellula	**AGRISP**	no control, soil tillage, crop rotation		high incidence in broccoli in monoculture in Spain
Slugs and snails		molluscicides, cultural practices, monitoring, traps	cultural practices, biocontrol	molluscicides not always effective, metaldehyde perceived to be better than ferric phosphate but there are contamination issues; biocontrol is expense; traps probably not effective and too expensive for field crops
Wild life damage		scarers, netting and shooting		nets and fences work but are expensive, birds get used to scarecrows, shooting can be effective; repellent seed treatment would be good if effective

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A summary of control strategies is given in Table 4, while more details can be found in **Annex 5**. *Delia radicum* is controlled effectively on Brassica vegetables by seed treatments (fipronil) or drenches with spinosad (or chlorpyrifos at the moment in the UK). Lepidoptera are controlled using nets, biological control using *Bacillus thuringiensis* and insecticides. Aphids are usually heavily parasitised by naturally occurring parasitoids and may be consumed by predators such as Syrphid larvae. However, when their presence affects crop quality, aphids can be controlled by selective insecticides such as pirimicarb or pymetrozine. Control of cabbage whitefly and thrips with insecticides is difficult and not very effective, particularly if control measures are not applied at the right time. Slugs and snails are controlled by cultural practices, traps, natural enemies such as nematodes and chemicals (metaldehyde and ferric phosphate). Control of pigeons is difficult and relies on scarecrows, nets, fences and shooting.

Bottlenecks

OSR

Cultural practices
In some countries it is not possible to avoid close proximity of Brassica crops in arable areas. Strong economic pressure to grow OSR leads to narrow crop rotations. In addition, there is a tendency towards no-tillage because it requires less labour and fuel.

Monitoring and decision support systems
For *Ceutorhynchus* spp. visual monitoring of oviposition holes is difficult and labour-intensive and economic thresholds differ across European countries. Determination of the size of *Delia radicum* infestations is difficult. For *Meligethes*, thresholds used in decision support systems are not linked to yield. For these reasons, decision support systems are not used by the farmers. Moreover, there is no incentive for the farmer to use them.

Chemical control
Recently, use of neonicotinoid seed treatments has been restricted in Europe. As a result, farmers rely heavily on insecticide sprays with pyrethroid compounds. Insecticides may be used preventively, and unnecessary 'insurance sprays' may be applied in many cases. Resistance to pyrethroids in *Meligethes aeneus* has been observed in various European countries. Pyrethroid resistance has also been observed in the cabbage stem flea beetle. Insecticides can have side effects on parasitoids. In addition, insecticides first affect pollen beetles that are weakened by pathogen infestations, which makes the pest populations healthier and more aggressive.

Alternative control strategies
Silicate rock dusts which are used to control insect pests are sometimes used in organic farming, but this approach is considerably more expensive and is more inconvenient to use, compared to pyrethroid sprays.
Products based on entomopathogenic fungi that are used to control the pollen beetle *Meligethes aeneus* are under development.

Brassica vegetables

Cultural practices
Preventive measures such as crop rotation can have a completely different effect when undertaken at a landscape scale rather than on a small scale. Functional agro-biodiversity is insufficient as a single measure, but may be an element that can help to reduce pest pressure.

Monitoring and decision support systems
Monitoring, forecasting and decision support systems (DSS) could improve the efficiency of treatment and may help to reduce the number of insecticide treatments. The major constraints are lack of knowledge, systems may be too difficult to use or they are unreliable or too expensive. The costs of precision monitoring or pheromone-based strategies such as mass trapping are judged to be too high.

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Chemical control
Pyrethroids and other broad-spectrum insecticides, including spinosad, which can also be used in organic farming, can have adverse side effects on non-target insects and beneficials. Broad spectrum insecticides can affect naturally occurring parasitoids that parasitise aphids. The limiting factors in the sustainable production of Brassica vegetables in organic farming are *Contarinia nasturtii* and *Delia radicum* (this last being a key pest in all countries) because they require the application of spinosad. This causes an imbalance in the system because spinosad can have adverse side effects on parasitoids and on the natural enemies of aphids and Lepidoptera if it is not properly managed.
Moreover, some insects, such as the cabbage whitefly, have already developed resistance to pyrethroids. Insecticide resistance has also been reported for *Spodoptera* in Spain. Pyrethroids, however, are cost-effective and for minor crops such as cabbage there are only a limited number of registered insecticides available. For some pests, effective insecticides that are used to control certain stages are not available. The registration of new compounds for minor use in some Brassica crops is limited. Application technology could be improved in many cases (drop-leg technology), but this is often too expensive for individual farmers.

Alternative control strategies
Insect-proof nets are expensive and can only be used in high value crops. Nets, however, also exclude parasitoids and sometimes worsen the situation. They can also create problems with other pests and diseases. In addition, the use of nets is often inconvenient and labour-intensive.
Biocontrol is often considered to be too expensive and less effective than insecticides.*Bacillus thuringiensis* is currently the only biocontrol agent used in the field. Biocontrol of slugs and snails with nematodes (Nemaslug) is expensive and results are variable. The registration of new biocontrol products is often hampered by complex requirements for EU registration.

Overview of research – missing implementation – missing testing – missing research

Pests of OSR and Brassica vegetables are clearly linked. OSR serves as a reservoir for vegetable pests such as cabbage whitefly, cabbage root fly, etc. This relationship deserves further study.

Reliable, cost-effective and simple monitoring systems and decision support systems would improve treatment efficacy and could help to reduce the number of chemical treatments.

Control strategies with fewer side effects on beneficials are needed. In this regard, existing knowledge about side effects could be explored further.

There is too little knowledge about spraying technology and alternative ways of applying insecticides. Seed treatments, drenching and precision spraying should be explored further.

Very little effort is being made to breed for pest resistance. It is not clear whether this is due to a lack of good resistance traits or whether this is a low priority in breeding. There is little funding available to fund phenotyping of the considerable amount of genetic variation that is available in gene banks and other collections of plant genetic diversity.

Alternative control strategies such as those using pheromones, increased plant resistance and monitoring of pathogen population dynamics to support proper resistance management should receive more attention. More applied research is needed on plant defence elicitors. These are compounds of chemical or biological origin that trigger the plant's own defence responses.

Functional biodiversity is not easy to implement and manage, and its efficacy is not proven and not predictable. It needs to be coordinated at a landscape scale.

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Weeds in OSR and Brassica vegetables

State of play

Grass weeds, such as black-grass (*Alopecurus myosuroides*) and volunteer weeds, and various broad-leaved weeds are problematic in OSR. They are typically controlled by pre-emergence and post-emergence herbicide sprays. In some countries, such as Denmark, there are only a few herbicides that can be used in OSR. Alternative strategies include wide row planting and mechanical control. Herbicide-resistant OSR varieties are available in the UK.

Weeds in Brassica vegetables are controlled by cultural practices such as rotation, fake-seeding, plant density and sowing date. Mechanical weed control and herbicides are used. A low dose herbicide system is used in the Netherlands. In Denmark, only one herbicide is allowed.

Weeds are also problematic in organic farming.

Innovation process and failure factors

In several countries monitoring of herbicide resistance in monocots and poppy is done. In addition, no new modes of action of herbicides are in the pipeline. Mechanical control of weeds is more labour intensive than chemical control.

Overview of research – missing implementation – missing testing – missing research

Mechanical control strategies could be an attractive option when looking at savings in seed costs, herbicides and growth regulators. Robotic weeders and other high-tech approaches could reduce selection pressure for herbicide resistance in weeds. Wide row planting allows the use of broad spectrum herbicides between the rows. Variety choice plant characteristics, such as speed of emergence and leaf position, can also influence weed control.

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Conclusions and Recommendations

Conclusions OSR

The drivers for implementation of IPM include legal requirements, technical aspects, economics, convenience and market demand/certification. In general there is a lack of effective IPM tools for OSR. Many non-chemical IPM measures are more challenging technically, are less convenient and more expensive. This explains why such IPM methods are not widely used in OSR. Moreover, growers are not driven to IPM by market demands or certification.

There is a strong economic pressure to grow OSR because the crop is profitable. This pressure often results in narrow crop rotations. In combination with no-tillage practices, this leads to a build-up of soil-borne diseases and pests. As a result, in conventionally grown OSR the same diseases and pests are increasing in importance throughout Europe. Fungi, insects and weeds develop resistance to pesticides, and fungal pathogens evolve, which break through existing resistances in OSR. The situation appears to be the worst in the UK, with newly-emerging diseases and pests that are linked to these cultural practices and that could also be a threat to other European countries. Disease control is based on the use of resistant varieties and fungicides. Resistant varieties may be lower-yielding and the resistance is likely to break down due to pathogen evolution and disease pressure. Fungicide resistance is already a serious problem in some European countries. Insect pests are also increasing in importance and are controlled by insecticide sprays with pyrethroids, which are often applied preventively and are not based on economic thresholds. The recent restriction in the use of neonicotinoid seed treatments in Europe will lead to a further increase in foliar insecticide sprays. Resistance to pyrethroids is already a problem and is likely to increase. Losses are high without chemical control. OSR serves as a reservoir for pests and diseases in Brassica vegetables if they are grown in close proximity, which is hard to avoid in some countries. Both broad-leaved weeds and grass weeds are problematic in OSR and have developed resistance to herbicides.

Recommendations for OSR

1. Disease problems can be reduced by crop rotation and by removing infected debris

Many of the disease problems in OSR could be better managed by preventive IPM measures such as wider crop rotations and by removing infected debris in combination with healthy, certified seeds and resistant varieties. This strategy works well in organic farming.

2. Resistance breeding efforts should be organised at the European level

For *Plasmodiophora brassicae*, *Leptosphaeria maculans*, and *Pyrenopeziza brassicae*, pathogen evolution should be monitored at the regional and European levels. Information is needed in the public domain about pathotypes and host resistance. A lot of research about resistance breeding is done by private companies, and they should be involved in this process. Standard sets of germplasm and pathotypes that can be used throughout Europe are needed. More research efforts are needed to obtain durable host resistance in combination with high yield.

When possible, breeding for general resistance should be encouraged.

Resistance breeding may also be an option for pest control and should receive more attention.

3. The use of pest control measures should be based on reliable, cost-effective and easy-to-use forecasting and decision support systems, and proper application technology

The use of fungicides should be based on reliable decision support systems, which is a challenge for black leg and *Sclerotinia*. Fungicide resistance needs to be monitored in the *Sclerotinia* population. The use of insecticides should be based on monitoring and forecasting systems with clear economic thresholds. Knowledge that is already available locally should be shared among European countries. Application technology of pesticides could be further improved.

4. More attention should be given to alternative control strategies

As an alternative to fungicides, more attention should be paid to the development and use of plant defence elicitors and biocontrol products that could be applied with the seed or during the season.

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The use of functional biodiversity, elicitors of resistance and biocontrol in disease and pest control is under-explored in OSR.

5. Farmers need incentives to use IPM based strategies in OSR

In OSR, farmers need incentives to implement IPM. The benefits of IPM in dealing with problems such as pesticide resistance and failure of plant disease resistance should be made clear. This could be done by on-farm pilot and demonstration experiments where farmers' best practices are compared with advisory-based practices, with an economic analysis of both systems.

Conclusions Brassica vegetables

A diverse range of Brassica vegetables is grown throughout Europe, which makes it hard to generalise. Diseases are more specific to certain regions and certain crops, while there are a few major pests that are common in all crops and regions. On Brassica vegetables, there is a lower tolerance for leaf pathogens than on OSR. In addition, post-harvest pathogens can cause problems when cabbages are stored. The main motivations for farmers to implement IPM in Brassica vegetables are certification systems, such as GlobalGAP, LEAF and Milieukeur. Leaf diseases in Brassica vegetables are generally controlled by fungicides, which are cost-effective and work well. For some vegetables, resistant varieties are available. Biopesticides are used to control soil-borne fungi. Certain OSR pests on Brassica vegetables can become problematic in countries where OSR and Brassica vegetables are grown in close proximity. OSR can act as a 'green bridge' in both space and time for the pests and pathogens of Brassica vegetable crops, and this is especially a problem in countries with a maritime climate where Brassica vegetables are grown year-round. Paradoxically, pests cause more problems in organic farming than in conventional farming. This is especially the case when broad-spectrum insecticides such as pyrethrins and spinosad are used, which can have adverse side effects on beneficials. Also the application of insect-proof netting can have adverse effects by excluding antagonists. Slugs, snails and pigeons are problematic in most Brassica fields.

Recommendations for Brassica vegetables

1. For disease control in Brassica vegetables, growers should first explore preventive measures

Most diseases in Brassica vegetables can be managed by preventive measures such as wide crop rotation, removal of infected debris, healthy certified seeds and the use of resistant or tolerant varieties when available. Adapted irrigation strategies can help in controlling *Hyaloperonospora* and *Xanthomonas*.

2. Resistance breeding in Brassica vegetables should be further explored

Resistance breeding in Brassica vegetables should be further explored, especially breeding for partial resistance. There is a huge amount of genetic variation within the Brassicas that could be screened and tapped for resistance against both diseases and pests. Techniques such as marker-assisted selection can speed up the breeding process.

3. New chemical or biocontrol products that can be used at the later stages of vegetable production are required

4. Side effects on beneficials should be considered when choosing control strategies

5. Selective control strategies without side effects on beneficials need to be explored further.

The main problem in pest control is the use of strategies that can have negative effects on beneficials. It is clear that new control strategies (fences, biocontrol agents, selective chemicals, innovative application techniques) that are more specific and that don't have any side effects are needed.

6. Combinations in the IPM toolbox need to be optimised

Combinations in the IPM toolbox such as management of natural enemies, biocontrol and biopesticides need to be optimised. When insecticides are used, they should be chosen and applied in such a way so as not to interfere with biological control strategies.

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We need information about field performance of biocontrol products and their use in combination with cultural practices, host resistance and fungicide use.

7. Wide implementation of IPM in Brassica vegetables could be encouraged through certification schemes driven by the market

In many certification schemes, IPM is not very dominant, but it is important. The food industry could be involved in increasing the demand for IPM, and increased demands of supermarkets could change the perspective of 'high cost' measures such as biocontrol, precision monitoring, pheromone-based strategies and mass trapping. The economics of high cost control measures will also change with scale.

General recommendations

1. Ideally, pests and pathogens should be managed at a greater spatial scale (landscape scale)

Ideally, the management of pests and pathogens of Brassica vegetables and OSR should be coordinated at a greater spatial scale (landscape scale) rather than at the field level. This could lead to preventative, long-term strategies to lower overall population levels of diseases and pests. This requires considerable collaboration between neighbouring farmers. Proper incentives are needed to make this happen.

2. Whole systems approaches are needed

A 'whole system' long-term approach should be taken to implement tools. This should be done together with farmers and extension services.

3. Growers need to be aware that OSR can serve as a reservoir for Brassica diseases and pests

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Annex 1. Members of the Focus Group

Oskars Balodis	Latvia	Integrated pest management (Sclerotinia, Phoma and Alternaria) of WOSR in the Nordic- Baltic region; factors that limit growth of WOSR in Northern regions.
Robert Baur		Entomologist for vegetable crops. Head of the "Plant Protection and Fruit and Vegetable Extension" research department.
Nicholas Birch	United Kingdom	Entomologist, IPM toolboxes and strategies for soft fruit and vegetables, including 'push-pull', 'biomomicry', 'biodeception'. Research and development on semiochemicals (attractants, repellents), monitoring and trapping, plant breeding for durable pest resistance, biocontrol, biopesticides, insect behaviour, landscape ecology, environmental risk assessment, GM crop biosafety and IPM compatibility.
Piet Boonekamp	Netherlands	Head of the broad research group on IPM tools: lab-based and on-site detection of pathogens in starting material and end products (including Quarantine organisms); development molecular monitoring of virulence pathogen and insects with semiochemicals in field populations, resistance management, developing biopesticides for pathogens and insects, beneficial micro-organisms for seeds and rhizosphere, food safety tools (mycotoxins, fytonoses), soil health microbiomes and influencing factors. Crops: potato, fruit trees, vegetables, horticulture, banana
Harm Brinks	Netherlands	Specialist on sustainable production of arable and open field vegetable crops. Introduction of Good and Best practices for soil management, crop protection and fertiliser strategies in practice, in cooperation with farmers and their stakeholders. Development of sustainable certification schemes based on market demands, in an international context. Active in The Netherlands and several European countries (focus on Eastern Europe), Africa and Asia
Paula Coelho	Portugal	Downy mildew (DM) resistance in vegetable brassica; pathotyping identification of H. brassicae pathogen; development of protocols for DM evaluation of germoplasm collections; genetic study of the control of DM resistance in sources with breeding value.
Rosemary Collier	United Kingdom	Entomologist focusing on IPM in outdoor vegetable crops. Specific expertise in pest monitoring, decision support, development of weather-based forecasts, phenotyping for host-plant resistance, application of insecticides and biopesticides as part of IPM strategies, physical methods of pest control, insect ecology, the use of polyculture to manage pest colonisation.
Claudia Daniel	Germany	Entomologist: Pest management in organic/low-input production systems - applied research in arable crops, fruit and vegetable production using functional biodiversity, biocontrol (predators,

		parasitoids, entomopathogenic fungi), organic pesticides (plant extracts, oil products, mineral products), push-pull-strategies (non-host volatiles), attract-and-kill strategies, interaction of fertilisation strategies with pest incidence
Bart Declercq	Belgium	General plant pathologist. Biological and integrated control of plant diseases. Plant pathogen interactions. Plant resistance mechanisms. Specialisation: Open field vegetables.
Bart Fraaije	United Kingdom	Plant pathologist, emphasis on fungus. Mechanisms leading to fungicide resistance utilising the latest advances in genomics/proteonomics.
Robbie Girling	United Kingdom	Entomologist, working on plant-insect interactions on Brassica species. IPM measures on several crops. Organic farming.
Emilio Guerrieri	Italy	Entomologist. Sustainable control of insect pests, multitrophic interactions (plant-pest-parasitoid; belowground-aboveground)
Sonia Hallier	France	Plant pathologist specialised in biological evaluation of alternative solutions (genetic resistance and biocontrol products) on brassica diseases under controlled (growth chambers) and semi-controlled conditions (greenhouses). Set-up and coordination of collaborative projects.
Monica Höfte	Belgium	General plant pathologist. Biological and integrated control of plant diseases. Plant-pathogen interactions. Soil-borne pathogens. Plant resistance mechanisms.
Martin Hommes	Germany	Entomologist, IPM specialist for vegetable crops esp. Cruciferous crops, evaluation of biopesticides
Jens Erik Jensen	Denmark	Scientist and farm adviser on IPM
Luca Lazzeri	Italy	Expert in natural bioactive molecules from brassicas and in brassica cultivation
Claudia Michel	Germany	Dipl. Ing. Agr. , Agricultural economist, plant protection, integrated pest management, integrated farming
Jane Thomas	United Kingdom	Integrated control of pathogens of oilseed rape, special interest in characterisation and deployment of cultivar resistance, focus on foliar and soil-borne fungal diseases. Also interests in diagnostics development and use in disease control strategies.
Luc Peeters	Belgium	M.Sc in agriculture-horticulture. General management Research and Development Center and Food Safety Control Institute. Adviser in food safety, microbial and pest and disease control regulations.
Xavier Pinochet	France	Biological and integrated control of plant diseases

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Annex 2. Common names of pests and diseases of oilseed rape and Brassica vegetables

Table A2.1. Common names of pests and diseases of oilseed rape

Latin names	EPPO Code	Common names							
		UK	NL and BE	FR	DE	IT	DK	PT	S
Fungi									
Plasmodiophora brassicae	PLADBR	clubroot	knolvoet	Hernie	Kohlhernie	Ernia del cavolo	kålbrok	hérnia	Hernia o potra
Alternaria brassicae and brassicola	ALTEBA	black spot, dark leaf spot	spikkelziekte	Alternaria	Rapsschwärze	Alternaria	stor skulpesvamp, lille skulpesvamp	alternariose	alternariosis
Mycosphaerella brassicicola	MYCOBR	ring spot	ringvlekken-ziekte, stip	Mycosphaerella	Ringfleckenkrankheit		kålbladplet	micosfarela, mancha das folhas	mancha parda
Verticillium longisporum	VERTLO	Verticillium wilt	verwelkings-ziekte	Verticilliose	Rapswelke	Verticillio	no Danish name	verticillium	verticiliosis
Fusarium oxysporum f. sp. conglutinans	FUSACO	yellows			Fusarium-Welke		Fusarium	fusariose	fusariosis vascular
Sclerotinia sclerotiorum	SCLESC	Sclerotinia white mould	sclerotiënrot	Sclerotinia	Weißstängeligkeit	Sclerotinia	storknoldet knoldbægersvam p	esclerotinia, podridão branca	esclerotinia
Leptosphaeria maculans (Phoma lingam)	LEPTMA	black leg, Phoma stem canker and leaf spot	Phoma	Phoma	Wurzelhals- und Stängelfäule	Marciume del colletto	rodhalsråd	pé negro	chancro, phoma
Pyrenopeziza brassicae	PYRPBR	light leaf spot		cylindrosporios e	Blattfleckenkrankheit		lys bladplet		
Typhula gyrans	TYPHGY	snow mould			Typhula-Fäule				
Pests									
Delia radicum	HYLERA	cabbage root fly, cabbage maggot	koolvlieg	mouche du chou	Kleine Kohlfliege	Larva del cavolo	lille kålflue	mosca da couve	mosca de la col
Myzus persicae	MYZUPE	peach-potato aphid	groene perzikluis	puceron vert du pêcher	Grüne Pfirsichblattlaus	Afide verde	ferskenbladlus	afídeos	pulgón verde

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Brevicoryne brassicae	BRVCBR	cabbage aphid	melige koolluis	puceron cendré du chou	Mehlige Kohlblattlaus	Afide del cavolo	kålbladlus	afídeos	pulgón ceniciento
Phyllotreta spp.	PHYESP	flea beetle	koolaardvlo	altise des crucifères	Kohlerdflöhe	Pulce del cavolo	jordloppe	álticas	pulguilla de la col
Psylliodes chrysocephala	PSYICH	cabbage stem flea beetle	koolzaadaardvl o	altise d'hiver du colza	Rapserdfloh		rapsjordloppe		pulguilla dela colza y del nabo
Psylliodes luteola	PSYILU	Wessex flea beetle							pulguilla del nabo
Ceutorhynchus pallidactylus (= C. quadridens)	CEUTQU	cabbage stem weevil	stengelboorsnui t kever	charançon du chou	gefleckter Kohltriebrüssler		bladribbesnudebil le	falsa potra	falsa potra de la col
Ceutorhynchus picitarsis	CEUTPI	Rape winter stem weevil	boorsnuitkever	charançon noir d'hiver du colza	schwarzer Kohltriebrüssler				falsa potra de la col
Ceutorhynchus napi	CEUTNA	rape stem weevil	boorsnuitkever	gros charançon de la tige du colza	Rapsstengelrüssler				falsa potra de la col
Ceutorhynchus obstrictus (= C. assimilis)	CEUTAS	cabbage seed weevil	koolzaadsnuitke ver	charançon de la graine du chou	Kohlschotenrüssler		skulpesnudebille		fasla potra de la col
Meligethes aeneus	MELIAE	pollen beetle	koolzaadglansk ever	méligèthe du colza	Rapsglanzkäfer	Meligete	glimmerbøsse		
Dasineura brassicae	DASYBR	Brassica pod midge	koolzaadhauwg almug	cécidomyie du colza	Kohlschotenmücke		skulpegalmyg		cecidomido de las vainas de las crucíferas
Other		slugs and snails	slakken	limaces et escargots	Schnecken		snegle	lesmas e caracóis	caracoles y babosas
		Wildlife damage	wildschade		Wildschaden		vildtskade		
		voles	veldmuis	campagnol	Feldmäuse				

Table A2.2. Common names of diseases of Brassica vegetables

Latin names	EPPO Code	Common names							
		UK	NL and BE	FR	DE	IT	DK	PT	S
Fungi									
Plasmodiophora brassicae	PLADBR	Clubroot	knolvoet	Hernie	Kohlhernie	Ernia del cavolo	kålbrok	hérnia	Hernia o potra
Hyaloperonospora parasitica (Peronospora parasitica)	PEROPA	downy mildew	valse meeldauw	mildiou	Falscher Mehltau	Peronospor a	kålskimmel	míldio	mildio
Albugo candida	ALBUCA	white blister rust	witte roest	Albugo	Weißer Rost		korsblomsthvidrus t	ferrugem branca	roya blanca
Phytophthora brassicae		Phytophthor a storage rot	Phytopthora bewaarrot	Phytophtora		Fitoftora	no Danish name	murchidão das plântulas	Phytophthor a
Botrytis cinerea	BOTRCI	grey mould	grauwe schimmel	Botrytis	Grauschimmel	Muffa grigia	gråskimmel	podridão cinzenta	podredumbr e gris
Alternaria brassicae and brassicola	ALTEBA	black spot, dark leaf spot	spikkelziekte	Alternaria	Rapsschwärze	Alternaria	stor skulpesvamp, lille skulpesvamp	alternarios e	alternariosis
Mycosphaerella brassicicola	MYCOBR	ring spot	ringvlekkenziekte, stip	Mycosphaerella	Ringfleckenkrankheit		kålbladplet	micosfarela , mancha das folhas	mancha parda
Verticillium longisporum	VERTLO	Verticillium wilt	verwelkingsziekte	Verticilliose	Rapswelke	Verticillio	no Danish name	verticillium	verticiliosis
Erysiphe cruciferarum	ERYSCR	powdery mildew	echte meeldauw	Oidium	Echter Mehltau	Oidio	korsblomstmeldug	oídio	oidio
Sclerotinia sclerotiorum	SCLESC	Sclerotinia white mould	sclerotiënrot	Sclerotinia	Weißstängeligkeit	Sclerotinia	storknoldet knoldbægersvamp	esclerotinia , podridão branca	esclerotinia
Rhizoctonia solani	RHIZSO	stem canker	zwartpoten	Rhizoctonia	Wurzeltöterkrankheit	Rhizoctonia	rodfiltsvamp	rizoctónia	rizoctonia
Leptosphaeria maculans (Phoma lingam)	LEPTMA	black leg, Phoma stem canker and leaf spot	Phoma	Phoma	Wurzelhals- und Stängelfäule	Marciume del colletto	rodhalsråd	pé negro	chancro, phoma

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Pyrenopeziza brassicae	PYRPBR	light leaf spot		cylindrosporiose	Blattfleckenkrankheit		lys bladplet		
Bacteria									
Xanthomonas campestris pv. campestris	XANTCA	black rot	zwartnervigheid	nervation noire du chou	Schwarzadrigkeit	Marciume nero	kålbrunbakteriose	bacteriose	mancha negra bacteriana
Pectobacterium carotovorum soft rot	ERWICA	bacterial soft rot	natrot	pourriture molle	Bakteriennaßfäule				podredumbre bacteriana
Pseudomonas fluorescens and *viridiflava*	PSDMFL, PSDMVF	bacterial head rot	schermrot					bacteriose	
Viruses									
Cauliflower mosaic virus	CAMV00	cauliflower mosaic	bloemkoolmozaiek		Blumenkohlmosaikvirus	Mosaico del cavolo	blomkålsmosaik	virús do mosaico da couve-flor	virus del mosaico de la coliflor
Turnip mosaic virus	TUMV00	turnip mosaic						virús do mosaico do nabo	virus del mosaico del rábano
Beet western yellows (=Turnip yellows virus)	BWYV00						TuYV (turnip yellows virus)		No spanish name

Table A2.3. Common names of pests of Brassica vegetables

Latin names	EPPO Code	Common names							
		UK	NL and BE	FR	DE	IT	DK	PT	S
Pests									
Delia radicum	HYLERA	cabbage root fly, cabbage maggot	koolvlieg	mouche du chou	Kleine Kohlfliege	Larva del cavolo	lille kålflue	mosca da couve	mosca de la col
Autographa gamma	PYTOGA	silver Y moth	gamma-uil	gamma	Gammaeule		gammaugle	nóctuas	plusia
Evergestis forficalis	EVERFO	garden pebble moth		pyrale des crucifères	Kohlzünsler				
Lacanobia oleracea	POLIOL	bright-line brown-eye	groente-uil	noctuelle potagère	Gemüseeule		haveugle		
Mamestra brassicae	BARABR	cabbage moth	kooluil	noctuelle du chou	Kohleule		kålugle	lagarta, caterpilar	rosquilla de la col; oruga nocturna de la col
Pieris brassicae	PIERBR	large white butterfly	groot koolwitje	grand papillon blanc du chou	Großer Kohlweißling	Cavolaia maggiore	stor kålsommerfugl	lagarta da couve	oruga de la col
Pieris rapae	PIERRA	small white butterfly,	klein koolwitje	petit papillon blanc du chou	Kleiner Kohlweißling	Cavolaia minore	lille kålsommerfugl	lagarta	oruga de las crucíferas

		cabbage white							
Plutella xylostella	PLUTMA	diamond back moth	koolmot	teigne du chou	Kohlmotte		kålmøl	traça da couve	polilla de las crucíferas
Myzus persicae	MYZUPE	peach-potato aphid	groene perzikluis	puceron vert du pècher	Grüne Pfirsichblattlaus	Afide verde	ferskenbladlus	afídeos	pulgón verde
Brevicoryne brassicae	BRVCBR	cabbage aphid	melige koolluis	puceron cendré du chou	Mehlige Kohlblattlaus	Afide del cavolo	kålbladlus	afídeos	pulgón ceniciento
Contarinia nasturtii	CONTNA	swede midge, cabbage crowngall fly, cabbage gall midge	koolgalmug	cécidomyie du chou	Kohldrehherzmücke		krusesygegalmyg		cecidomido de las cruciferaas
Aleyrodes proletella	ALEUPR	cabbage whitefly	koolwittevlieg	aleurode du chou	Kohlmottenschildlaus	Mosca bianca del cavolo	kålmellus	mosca branca	mosca blanca de las crucíferas
Thrips tabaci	THRITB	thrips	trips	thrips	Zwiebelthrips	Tripide del tabacco	trips, nelliketrips	tripes	trips de la cebolla; trips del tabaco
Botanophila fugax	HYLEFU	leafmining fly larvae	koolbladvlieg		Rosenkohlfliege				
Phyllotreta spp.	PHYESP	flea beetle	koolaardvlo		Kohlerdflöhe	Pulce del cavolo	jordloppe	álticas	pulguilla de la col

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Meligethes aeneus	MELIAE	pollen beetle	koolzaadglanskever	méligèthe du colza	Rapsglanzkäfer	Meligete	glimmerbøsse		
Athalia rosae	ATALCO	Turnip sawfly	knollebladwesp	tenthrède de la betterave	Kohlrübenblattwespe	Atalia	kålbladhveps		falsa oruga de los nabos
Scaptomyza flava	SCATFL	leaf miner	koolmineervlieg		Rapsminierfliege		kålminerflue		
Spodoptera exigua, S. littoralis	LAPHEG							lagarta	gardama
Scutigerella immaculata	SCUTIM							scutigerella	tijereta
Nematodes									
Heterodera schachtii	HETDSC	sugarbeet cyst nematode	bietencystenaaltje	nématode de la betterave	Rübenzystenälchen	Nematode cisticolo	roecystenematode	nemátodos	nematodo quiste de las crucífera
Heterodera sp.	HETDSP				Zystenälchen	Nematode cisticolo	cystenematode		
Meloidogyne sp.	MELGSP				Wurzelgallenälchen	Nematode galligeno	rodgallenematode		nematodo agallador
Heterodera cruciferae									nematodo quiste de las cruciferas
other		slugs and snails	slakken	limaces et escargots	Schnecken		snegle	lesmas e caracóis	caracoles y babosas

		Wildlife damage	wildschade		Wildschaden		vildtskade		
		voles	veldmuis	campagnol	Feldmäuse				

Annex 3. Economically important Brassica crops in Europe

The genus *Brassica* belongs to the *Brassicaceae* (also called *Cruciferae*) or mustard family, and contains many important crop species which provide edible roots, leaves, stems, buds, flowers and seeds (Rakow, 2004). The origin of the different *Brassica* species is presented in Figure Annex 3.1. Economically important Brassica crops belong to the species *B. oleraceae*, *B. rapa* (also called *B. campestris*), *B. napus*, a species derived from interspecific crosses between *B. oleraceae* and *B. rapa*, and *B. juncea*, a species derived from interspecific crosses between *B. rapa* and *B. nigra*. Economically important Brassica species can be divided in Brassica vegetables, which predominantly belong to the species *B. oleraceae* and *B. rapa* and the *Brassica* oilseeds, which belong to the species *B. napus* and *B. rapa* (Table Annex 3.1.)

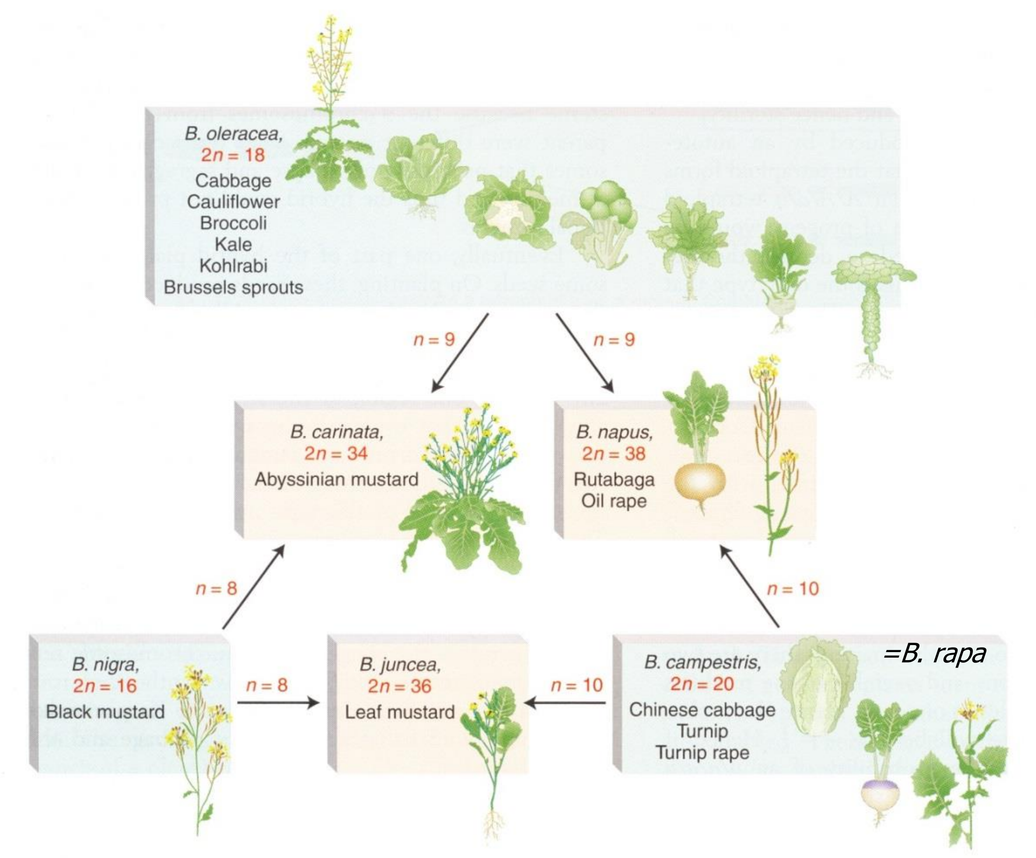
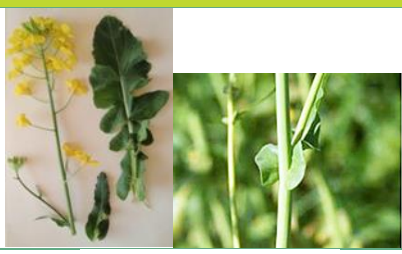


Figure A3.1. Origin of the different Brassica species (Griffiths et al., 2005)

Table A3.1. Important Brassica species grown in Europe

Latin name	Common names		Major producing countries*
Brassica oleraceae			
var. acephala	kale, borecole, grünkohl, boerenkool		Germany
var. capitata -rubra	headed cabbage, sluitkool -red cabbage		Turkey, Germany, Hongary, Poland, Benelux, UK, France, Scandinavia
-alba	-white cabbage		Romania, Poland, Germany, Greece, Spain, Turkey, UK, Italy, Benelux, France
-conica	-pointed cabbage		Germany
var. sabauda	savoy cabbage, col de savoya, savooiekool		UK, Italy, Spain, Hongary, France, Germany, Poland, Benelux
var. gemnifera	Brussels sprouts, coles de Bruselas, choux de Bruxelles, rosenkohl, spruitkool		Belgium, Netherlands, UK, Poland
var. botrytis	cauliflower, coliflor, chou-fleur, blumenkohl, bloemkool		France, UK, Italy, Belgium, Spain, Portugal, Turkey, Germany, Belgium, Hongary, Netherlands
var. italica	Broccoli, broccoli, brécol		Spain, UK, Italy, Poland, Benelux, Germany, France, Turkey, Portugal, Greece
var. gongylodes	Kohlrabi, chou-rave, koolrabi, German turnip		Germany

Latin names	Common names		Major producing countries*
***Brassica rapa* (= *Brassica campestris*)**			
var. pekinensis	Chinese cabbage, Chinese kool, Chinakohl, chou chinois		Germany
var. chinensis	Paksoi, pak choi, Chinese mustard		
var. rapa	Turnip, knolraap, rübe, navet		
ssp. oleifera	Turnip rape, rapeseed, raapzaad		Poland, Sweden, UK, Finland
Brassica napus			
ssp. oleifera	Oilseed rape, koolzaad, colza, raps		France, Germany, UK, Poland, Czech Republic, Sweden, Hungary, Bulgaria, Denmark, Slovakia, Romania, Sweden
	Rutabaga, swede, yellow turnip, nabicol, koolraap, kohlrübe		Germany
Brassica juncea			
	Brown mustard, leaf mustard, indian mustard, moutarde brune, brauner senf, sareptamosterd		

*According to Eurostat and Groentemagazine

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Annex 4. Most important diseases and pests on oilseed rape and Brassica vegetables

Table A4.1. Most important diseases of OSR in Europe

	Key pest	Secondary pest	No problem
Fungi			
Plasmodiophora brassicae	All countries		
Verticilllium longisporum	ES/LV/SE/FR	UK/GE	CH/DK
Sclerotinia sclerotiorum	UK/CH/DK	LV/SE/FR/DE	
Leptosphaeria maculans (Phoma lingam)	UK/CH/LV/DK	FR/GE	SE
Pyrenopeziza brassicae	UK	DK/FR	GE/CH/LV/SE
Viruses			
Beet western yellows (= Turnip yellows virus)	UK/SE/DK	FR	CH/LV/DE

Table A4.2. Most important diseases of Brassica vegetables in Europe

	broccoli			cauliflower			white cabbage		
	key pest	secondary pest	no importance	key pest	secondary pest	no importance	key pest	secondary pest	no importance
Fungi									
Plasmodiophora brassicae	GE/Pt/NI/UK/IT/BE	F		GE/NL/UK/Pt/IT/BE	F		GE/NI/UK/Pt/IT	F/BE	
Hyaloperonospora parasitica (Peronospora parasitica)	Pt/FR	GE/NI/UK/BE	IT	GE/PT	NL/UK/F/BE	IT	UK	NL/Pt/F/BE	GE/IT
Albugo candida		PT/F	GE/NI/UK/IT/BE		Pt/BE	GE/NL/UK/IT/F	NL	Pt/BE	GE/UK/IT/F
Phytophthora brassicae		IT	GE/Pt/NI/UK/F/BE		IT/F	GE/NL/Pt/UK/BE	NL/BE	UK/IT/F	GE/Pt
Alternaria brassicae and brassicola	Pt/NI/BE	GE/UK/IT	F	GE/NL/IT/BE	Pt/UK	F	GE/NI/IT/BE	UK/Pt	F
Mycosphaerella brassicicola	Pt/NI/F/BE	GE/UK/IT		NL/F/BE	GE/Pt/UK/IT		NI/Pt/F/BE	GE/UK/IT	
Verticilllium longisporum			GE/Pt/NI/UK/IT/F/BE	GE/IT/BE		NL/Pt/UK/F		UK/BE	GE/NI/Pt/IT/F
Erysiphe cruciferarum		NI/UK/IT/BE	GE/Pt/F	IT	NL/UK/BE	GE/Pt/F	IT	GE/NI/UK/BE	Pt/F
Sclerotinia sclerotiorum	IT	F/BE	GE/Pt/NI/UK		UK/IT/F/BE	GE/NL/Pt	IT/BE	GE/UK/F	NL/PT
Rhizoctonia solani		GE/NI/UK/IT/F/BE	Pt	B	GE/NL/UK/IT/F	Pt	B	GE/NI/UK/IT/F	Pt
Leptosphaeria maculans (Phoma lingam)		GE/Pt/NI/IT	UK/BE		GE/NL/Pt/IT	UK/BE		GE/NI/UK/Pt/IT	BE
Pyrenopeziza brassicae		NL/UK	GE/Pt/IT/F/BE		NL	Pt/UK/GE/IT/F/BE		UK	NI/GE/Pt/IT/F/BE
Stemphylium sp. (brown spot)		Pt	GE/NI/UK/IT/F/BE		Pt	NL/UK/GE/IT/F/BE	Pt	UK	NI/GE/IT/F/BE
Bacteria									
Xanthomonas campestris pv. campestris	NL/BE	GE/Pt/UK/IT	F	GE/NL/IT/BE	Pt/F		BE	GE/PT/IT	F
Pectobacterium carotovorum soft rot		NI/BE	GE/Pt/UK/IT/F		NL/UK/BE	GE/Pt/IT/F		GE/NI./UK/IT/BE	PT/F
Pseudomonas fluorescens and *viridiflava*	NL/F/BE		GE/Pt/UK/IT	BE	GE/IT	Pt/UK/F			GE/NI/UK/PT/IT/F/BE
Viruses									
Cauliflower mosaic virus		UK	GE/Pt/NI/IT/F/BE		UK	GE/Pt/IT/F/BE		UK	GE/NI/Pt/IT/F/BE
Turnip mosaic virus		UK	GE/Pt/NI/IT/F/BE		UK	GE/Pt/IT/F/BE		UK	GE/NI/PT/IT/F/BE
Beet western yellows = Turnip yellows virus		UK	GE/Pt/NI/IT/F/BE		UK	GE/Pt/IT/F/BE			GE/NI/UK/PT/IT/F/BE

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Table A4.3. Most important pests of oilseed rape in Europe

Latin name	Key pest	Secondary pest	No problem
Delia radicum	DK/DE/SE/UK	CH	LV
Phyllotreta spp.	SE/LV	DK/IT/GE/UK	CH
Psylliodes crysocephala	CH/LV/UK/GE	DK/SE	
Ceutorhynchus pallidactylus	DK/CH	UK/GE	SE/LV
Ceutorhynchus napi	CH/IT		DK/UK/DE
Ceutorhynchus assimilis	DK/UK	SE	CH/LV
Meligethes aeneus	IT/GE/CH/UK/DK		
Dasineura brassica		GE	UK/CH/SE/LV
slugs and snails	UK	CH/GE	
wild life damage	UK	GE	CH/DK

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Table A4.4. Most important pests of Brassica vegetables in Europe

	broccoli			cauliflower			white cabbage		
	key pest	secondary pest	no importance	key pest	secondary pest	no importance	key pest	secondary pest	no importance
Nematodes									
Heterodera schachtii		GE/NI/IT/BE/CH	Pt/UK/F/CH		GE/IT/CH	Pt/UK/F/CH		NL/UK/BE/CH	GE/PT/IT/F/CH
Meloidogyne sp.	IT	NI/BE	GE/Pt/UK/F	IT		GE/Pt/UK/F/CH	IT	NI/BE	GE/UK/PT/F/CH
Insects									
Delia radicum	all countries			all countries			all countries		
Lepidopteras	all countries			all countries			all countries		
Spodoptera spp.	IT/SP/Pt		other countries	IT/SP/Pt		other countries	IT/SP/Pt		other countries
Myzus persicae			NL/CH/GE		NL/CH/GE		IT	NL/CH/GE	
Brevicoryne brassicae	UK/GE	NL/CH/IT		UK/GE	NL/CH/IT		NL/UK/GE	CH/IT	
Contarinia nasturtii	CH/GE	NL/UK/BE	IT	CH/GE	NL/UK/BE	IT	NL	UK/CH/GE/IT/BE	
Aleyrodes proletella		NL/CH/UK/GE			NL/CH/UK/GE	IT		NL/CH/UK/GE	IT
Thrips tabaci			NL/CH/GE/UK			NL/CH/GE/UK		NL/UK/GE/CH	
Phyllotreta spp.	CH	GE/UK/IT	NL	CH	GE/UK/IT	NL	CH	NL/GE/UK/IT	
Ceutorhynchus		CH/UK	NL/GE/IT		CH/UK	NL/GE/IT		UK	NL/CH/IT/GE
Meligethes		CH/GE/UK	NL		CH/GE/UK	NL			NL/CH/GE/UK
snugs and snails	all countries			all countries			all countries		

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Annex 5. IPM practices to control pests and diseases of oilseed rape and Brassica vegetables

The tables below are available on the EIP-AGRI website:

- **on the IPM Brassica Focus Group page**:

  https://ec.europa.eu/eip/agriculture/en/content/integrated-pest-management-ipm-focus-brassica-species

- **in the collaborative area of the Focus Group IPM Brassica** (only accessible to members of the Focus Group):

  https://ec.europa.eu/eip/agriculture/content/collaborative-area-focus-group-integrated-pest-management-ipm-focus-brassica-species

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Annex 6. Mini-papers

A number of mini-papers related to IPM in Brassica were drafted by some members of the EIP-AGRI Focus Group. These mini-papers offer interesting considerations from experts of the Focus Group, on different topics of interest.

1. IPM: how to get from IPM concepts to a successfully implemented IPM system
2. Effects of landscape and region on pests and pathogens in *Brassica* vegetables and oilseed rape
3. Monitoring and forecasting systems used in Europe
4. Plant protection in organic production of *Brassica* vegetables and oilseed rape
5. Ecological selectivity of pesticides and application methods
6. The potential for identifying and utilising sources of host plant resistance to the pests and pathogens of *Brassica* crops as a key component of future IPM strategies
7. Side effects of pesticide applications
8. Clubroot in Brassica

Please note that these mini-papers are **not the outcome, nor the result of discussions in the Focus Group.** They only reflect the views of the authors.

They can be found on the following address:

https://ec.europa.eu/eip/agriculture/en/content/integrated-pest-management-ipm-focus-brassica-species

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Annex 7. Field visit to production area of Torrepacheco, Murcia, Spain

January 30th 2014

During the first meeting of the EIP-AGRI Focus Croup on IPM in Brassica crops a field visit was organised together with the Office for Technology Transfer of the Government of Murcia.

In the Murcia region, crops are grown all year round and their production is quite intensive. Crop production increased during the mid 1980s when Spain joined the EU. Most companies in the Murcia region are now cooperatives. The main summer crops are melons and watermelons, the main winter crops are salads, cauliflower and mainly broccoli. Peppers and tomatoes are also grown in the region (tomatoes more towards the south from Murcia), as well as (sweet) potatoes and a wide variety of other vegetable crops. 90% of vegetables grown in the Murcia region are exported (Europe): 100% of the exported crops go to Germany and the UK. 70% of all broccoli in the UK is provided by Murcia.

The main issue in the region itself is water availability and water quality. With an average rainfall of 300 mm per year, most crops rely on irrigation (550l/m^2/y).

IPM was introduced some years ago, starting with a successful governmental action plan for 'clean agriculture'.100% of peppers covered "under glass" are now grown under IPM and are using biological control. This action plan illustrated showed how important it is to let farmers understand the benefits that IPM can have for themselves (and not Implementing IPM and using biological control seems more difficult for open field crops. Imposing IPM by environmental law was expected not to be effective. However, an initiative from the retail organisation gave growers in the region an incentive to implement IPM in the open field as well. The AgroTomy cooperative is an exclusive provider for Tesco. To be able to deliver, the cooperative developed cropping systems under IPM, and their own technicians support the farmers through warning systems and by providing advice. Every 3 months, auditors from the customer (Tesco) visit the cooperative and its field, and check the products. More retailers are monitoring their products in this way.

Cabbage field

The cooperative's cabbage field is harvested 4-5 times, because customers are looking for a specific size of cabbage (0.5 kg). Field workers harvest the cabbages and pack them directly on the field, using special machinery. The product reaches the supermarket in the UK within 48 hours. In 2013 the field was sprayed with pesticide 3-4 times. The water use was 200-300 l/m^2.

All plant material is prepared by seedling companies. Planting is mostly done by hand, for salads special planting machines are also used. After harvesting, it is very common to have a flock of sheep on the field to eat the leaves. This is cheaper than collecting leaves and taking them to the sheep.

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Annex 8. Status of European research on IPM Brassica

This refers to "Overview of research – missing implementation – missing testing – missing research"

An overview of relevant research and innovation activities is given here. The list is not intended to be exhaustive, but is an indication of recent and current activities.

Crop	Country/ countries	Name	Description	Date	contact	Funding	Partners
Wild and cultivated Brassica	IT, RO, SP, PT	COCHEVABRAS	COCHEVA BRAS - "Collection, Characterization and Evaluation of wild and cultivated Brassicas" Please see **http://www.ecpgr.cgiar.org/resources/ecpgr-information-bulletin/** (COCHEVA BRAS webpage)	2015-2016	fbranca@unict.it	Bioversity International	UNICT, VRDS Bacau, CRA IAA, CSIS COR, INIAV, UTAD
Cabbage	DK, FR, DE, SI, NL, UK	PURE	Workpackage in the collaborative EU project "PURE- Pesticide Use-and-risk Reduction in European farming systems with Integrated Pest Management" **http://www.pure-ipm.eu**	2011-2015	martin.hommes@jki.bund.de	EU Grant agreement number: FP7-265865	AU, DLO, JHI, JKI, INRA, KIS
Cabbage	DE	Demofarms	Presenting and implementing IPM on demonstration farms **http://demo-ips.jki.bund.de**	2014-2017	annett.gummert@jki.bund.de	BMEL-Federal Ministry of Food and Agriculture	3 Länder in Germany
Brassica vegetables	UK	VeGIN	Vegetable Genetic Improvement Network **http://www2.warwick.ac.uk/fac/sci/lifesci/research/vegin/**	2014-2016	Peter.G.Walley@warwick.ac.uk	Defra	

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Oilseed rape	UK	OREGIN	Oilseed rape Genetic Improvement Network **http://www.oregin.info/**	2014-2016	peter.eastmond@rothamsted.ac.uk	Defra	
Brassica and leek	Belgium		Sustainable control of bacterial disease in the nurseries of cabbages and leek	2011- 2015	Bart.Declercq@inagro.be	IWT	Inagro PCG, PSKW, University of Leuven ILVO
Vegetables	Belgium		Support of low residue growing of vegetables by a web model	2012- 2016	Sabien.pollet@inagro.be	IWT	Inagro PCG PSKW Ghent University
Vegetables	Belgium		Biological control of Verticillium wilt with the help of an endophytic Verticillium tricorpus	2011- 2015	Monica.Höfte@ugent.be	IWT	Inagro PSKW Ghent University
Brassica and leek	Belgium		IPM control in vegetables: monitoring and advice	yearly	Bart.Declercq@inagro.be	LAVA (Belgian auctions)	Inagro, PSKW, PCG

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Annex 9. Innovative action: existing relevant interactive innovation projects and ideas for Operational Groups on IPM Brassica

This refers to: Recommendations/ideas for Operational Groups – recommendations for the dissemination of results and solutions – recommendations on how to ensure a broader take-up

Existing examples:

Type of action: **(research project, innovative action, thematic network, multi-actor project, etc.)**	**Country**	**Description**	**Contact Email**	**Website**
Multi-actor applied research	UK (Sc)	Developing an IPM Toolbox on *Brassica* (Oilseed rape) with farmers and industry.	nick.birch@hutton.ac.uk	Starting in 2016, funded by MS
Multi-actor applied research	CH	Implementation of non-chemical pest control in *Brassica* vegetables (incl. radish): on-farm evaluation of potential solutions, such as nets and biocontrol. Evaluation includes control efficacy, effects on weeds, diseases and other pests, practicability, yield risks and farm economics. Project team includes farmers, advisers, researchers and (for priority setting and project evaluation) farmer's association.	Ute.vogler@agroscope.admin.ch	
Multi-actor best practices	CH	National pest and disease warning and forecasting service for vegetable crops, including *Brassica*. Local pest and disease monitoring by regional advisory services and data transfer to Agroscope. Compilation of data, including cabbage root fly forecasting (using model SWAT); data and crop protection recommendations published weekly in crop protection bulletin "Gemüsebau Info" by Agroscope.	Cornelia.sauer@agroscope.admin.ch	www.agroscope.admin.ch
Multi-actor research	DE	PURE (EU PF) workpackage 4. Develop, test, exchange crop protection measures in *Brassica* growing. (research, farmers, advisory)	martin.hommes@jki.bund.de	www.pure-ipm.eu (workpackage 4)

Multi-actor research	DE	Demo Betriebe Integrierter Pflanzenschutz im Gemusebau (Demo farms IPM: vegetables)	martin.hommes@jki.bund.de	**http://demo-ips.jki.bund.de**
Multi-actor applied research, producer organisation led best practices, certification scheme	BE	Regionaal monitoring- en waarschuwingssysteem (onderzoek, Belorta, boeren). Waarnemingen op regionale referentiepercelen worden vertaald naar advies en via elektronische berichtgeving en informatie op internet naar de telers gebracht. Bloemkool, spruiten, sluitkool Regional monitoring and warning system (research, auction and farmers). Reference plots are monitored. Regionalised advice based on the reference plots is spread to farmers using text messages and internet. *Brassica*: Cauliflower, Brussels sprouts, white cabbage	Luc.peeters@belorta.be	
Certification scheme	NL, SP, DE, FR, UK, Ken, SA	Milieukeur II Certificatiesysteem voor duurzame goederen en diensten. Certification system for sustainable products and services. The criteria for Milieukeur are established by a set of procedures under the responsibility of the Panels of Experts for agro/food and for non-food. Producer organisations, the retail trade, government, scientists, ecologists and consumer groups are represented on the Panels. Includes implementing certification schemes into vegetable growing. Among energy use, water, labour circumstances, fertiliser use and biodiversity IPM is one of the issues addressed. The retail and food process industry is rewarding growers with Milieukeur II	Harm.brinks@dlv.nl	**www.milieukeur.nl** (also in English)

Multi-actor applied research and best practices	UK	Several forecasting systems UK HDC Pest Bulletin: Pest forecasting service for growers, resulting bulletins on Syngenta web site (vegetable pests) Rothamsted Suction trap network (Rothamsted Insect Survey) and the AHDB Aphid News. Migrant moth spp pest system: developing network of pheromone traps with cameras so that daily captures can be viewed on a website. Involving AHDB and growers together with a technical company from Slovenia.	Rosemary.collier@warwick.ac.uk	HDC Pest Bulletin HDC Pest Blog http://www.rothamsted.ac.uk/insect-survey http://www.hgca.com/publications/2014/september/05/integrated-aphid-advisory-alerts.aspx http://aphmon.fera.defra.gov.uk/ahdbAphidNews.cfm
Multi-actor research	UK	Crop Genetic Networks UK Vegin: Vegetable Genetic Improvement Network. Looking for useful traits in vegetables (including host plant resistance), *Brassica* is involved Oilseed rape genetic improvement network (OREGIN) Led by researchers and includes seed companies and growers.	Rosemary.collier@warwick.ac.uk	http://www2.warwick.ac.uk/fac/sci/lifesci/research/vegin/ http://www.oregin.info/
Multi-actor research	UK	The Waitrose Agronomy Group is a collaboration of suppliers, Waitrose and academia. PhD project: Identify the opportunities for IPM in outdoor crops in the UK and build whole-crop IPM programmes that can be tested by the members of the Agronomy Group in comparison with their own practice.	Rosemary.collier@warwick.ac.uk	http://sustainableagriculturewaitrose.org/research/the-agronomy-group/
Private applied research	IT	Ten-year research programme financed by private company Agrium Italia (ex Cerealtoscana) on "Programme of improving	Luca Lazzeri	http://www.cracin.it

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		and optimisation of materials, formulation and plants for Biofumigation. Development of new plants and materials from brassicaceae, as a vegetable source for plant defence and management through non-chemical options.	Luca.lazzeri@entecra.it	
Research	IT	"Technologies integrated systems for the valorisation of the co-products from Biodiesel Chain (VALSO)" Financed by the MiPAAF DM 17533/7303/2006 del 29/07/2010. Year 2011–2014" Definition of new defatted seed meals for an application of biologically active molecules from Brassicaceae in plant defence and management	Luca Lazzeri Luca.lazzeri@entecra.it	**http://www.cracin.it**
Multi-actor research	IT	"Programma Multioperativo (POM) B30 financed by the EU "Innovative cultivation techniques for plant defence with reduced impact in strawberry cultivation in the South of Italy" years 1999-2001".	Luca Lazzeri Luca.lazzeri@entecra.it	**http://www.cracin.it**

Ideas:

Type of action: **(research project, innovative action, thematic network, multi-actor research project, etc.)**	**Country**	**Description**	**Contact Email**
		Combining IPM tools in practice	
On-farm multi-actor research project Innovative action		Design of low pesticide input cropping systems for Brassica vegetables (or "IPM"-systems): • Implement elements from "toolbox" on farms • Gather experience (incl. economics)	

Network		• Share with other OGs in other regions/countries • Improve systems	
On-farm multi-actor research project Innovative action Network		Cabbage without insecticides: • Questions about type of nets, effect on climate and fungi development • Weed control • Planning • Quality aspects • Mechanisation	
		Integrated weed management in Brassica crops – mechanical control, band spraying, cover crops, etc.	
On-farm multi-actor research project Innovative action Network	BE, UK, NL	Improve on IPM in Brussels sprouts	
Research project		Evaluation of tools for control of Brassica pests – conservation biocontrol, biopesticides etc.	rosemary.collier@warwick.ac.uk
Research project		Development of integrated pest and disease strategies for Brassica crops (oilseed rape, vegetables) using all information available, whole crop system, development IPM toolbox	rosemary.collier@warwick.ac.uk
Operational Group project, Thematic Network		Looking for synergy between alternative solutions (especially partial resistance and biocontrol products to show success is possible towards: • Brassica diseases (RDP OG) • Oilseed rape diseases (Horizon 2020)	Sonia.hallier@yahoo.com
Research project		Clubroot on brassicas: looking for environmentally friendly solutions such as disease resistance, biocontrol products and global IPM strategy	Sonia.hallier@yahoo.com

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(Regional) network		Area-wide pesticide-free management of *Meligethes* – local farmers' network: • Functional biodiversity • Entomopathogenic fungi or other biocontrol • Focusing on overwintering sites • Aggregation pheromones • Compare thresholds in different EU countries • Set up new thresholds not only based on product price for pesticides but also on side effects	claudia.daniel@fibl.org
		Implementing existing results	
		Implement existing results of previous research projects before developing new ones	
		Implementing flower strips in practice	
		Common structure and apps for pest and disease monitoring in Brassica	
		Implementing the use of DSS in practice	
	E.g. Baltic region	DSS adaption on regional scale across countries	
		Management and design of field margins to increase functional agro-biodiversity in brassica crops	guerrieri@ipp.cnr.it
		Introducing pathogen diagnostics into "real time" decision making in the field of IPM	jane.thomas@niab.com

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		Working with farmers	
Advisory service networking with farmers		Impact of easily accessible independent advisory service on pesticide use and yields ○ Network of farmers divided into 2 groups: 1) With an independent adviser accessible round the clock, training on thresholds, leaflets etc. 2) Farmers without special/additional advice ○ Output/measurements: ▪ Pesticide applications (numbers + costs) ▪ Economic analysis	claudia.daniel@fibl.org
Best practices farms' network		Combine existing regional work from different neighbouring countries with more or less similar crops and farming systems 1) Perform best practices on some example farms, guidance researcher, based on indicated key pests and diseases 2) Assure some compensation for yield loss 3) Let farmers train each other in discussion groups 4) Let then report on constraints, improvements etc.	piet.boonekamp@wur.nl
On-farm demonstration		On-farm demonstration trials comparing: • Farmers' usual practice • Improved management system relying on functional biodiversity, biocontrol and selected low-risk pesticides, resistant varieties Aim is to show viability of improved management systems and economic analysis of both systems (marketable yields, costs of measurements, subsidies)	claudia.daniel@fibl.org

Discussion group		Fungicide use on disease-resistant material – perceptions and reality – discussion group – why do growers treat resistant material the same as susceptible crops?	jane.thomas@niab.com
Multi-actor discussion group		A discussion group/network between farmers and retailers (buyers) • Regular field visits • Spraying schedules noted down by farmers • Pesticide residues analysed in harvested crops Aim is to show retailers on-farm practice and why pesticides are used, making retailers re-think their requirements to finally reduce pesticide applications which are only applied against "cosmetic" problems and to ensure justified prices for farmers	claudia.daniel@fibl.org
		Information exchange	
Thematic network		European "information" network – who works on which problem where? Increase collaboration information exchange	rosemary.collier@warwick.ac.uk
Thematic network		Pan-European working group(s) for IPM in oilseed rape and Brassica vegetables	
Thematic network		EU-wide network of demonstration/ exchange platform	
Thematic network		State of the art/crop specific IPM guidelines for selected Brassica crops	

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Discussion group		General discussion group – biocontrol agents on farm – perceptions, desirability, acceptance	jane.thomas@niab.com
		Soil aspects	
		Significance of soil microflora/fauna changes under close rotation oilseed rape cropping, impact on productivity and options for control	jane.thomas@niab.com
		A proposal for a real IPM approach that starts from soil fertilities and low environmental impact that comprises bio-based technical means	luca.lazzeri@cracin.it
		Soil symbionts for the sustainable control of soil-borne pests and pathogens of Brassica plants	guerrieri@ipp.cnr.it
		Evaluation of biofumigation technique by 100% biobased material for plant management and defence. From biofumigant green manure to pellets and liquid formulations. Series of proposals for the farmers	luca.lazzeri@cracin.it

		Host resistance and pathotyping	
		Cultivar host resistance to Brassica (pests) and diseases	
		Improving disease partial resistance (more durable + synergy with elicitors) in Brassica (RDP OG) and in oilseed rape (Horizon 2020)	Sonia.hallier@yahoo.com

		European oilseed rape disease 'pathotype' monitoring to build on existing work and extend it	jane.thomas@niab.com
		More fundamental aspects – understand 'responsive genotypes' at genetic level, inform plant breeding programmes	jane.thomas@niab.com
		Monitoring and DSS	
		Monitoring of key diseases of oilseed rape. Are the monitoring systems so far developed to make some IPM strategies (Baltic region, LT, EE, LV)	
		Developing new tools for monitoring diseases in Brassica	Sonia.hallier@yahoo.com
		Optimisation and increased availability of European Decision Support Systems	rosemary.collier@warwick.ac.uk
		Forecasting and decision support for *Sclerotinia sclerotiorum*	

		Decision support system/economic thresholds for *Meligethes* : • Compare thresholds in different EU countries • Set up new thresholds not only based on product price for pesticides but also on side effects	claudia.daniel@fibl.org
		Catchment management strategies for pests of Brassica – slugs and maybe insects. Landscape scale	rosemary.collier@warwick.ac.uk

		Pesticide resistance and non-target effects	
		Status of pesticide resistance in Brassica pests and diseases	
		Non-target effects on new families of pesticides used in Brassica crops	guerrieri@ipp.cnr.it
		Alternative strategies	
		Use of plant boosters – pest and diseases, yield and quality	

eip-agri
AGRICULTURE & INNOVATION

The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- the EU Research and Innovation framework, Horizon 2020,
- the EU Rural Development Policy.

An EIP AGRI Focus Group* is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, EIP-AGRI Focus Groups temporarily bring together around 20 experts (farmers, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

The concrete objectives of a Focus Group are:

1. to take stock of the state of art of practice and research in its field, listing problems and opportunities;
2. to identify needs from practice and propose directions for further research;
3. to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

Results are normally published in a report within 12-18 months of the launch of a given Focus Group.

Experts are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

*More details on EIP-AGRI Focus Group aims and process are given in its charter on: http://ec.europa.eu/agriculture/eip/focus-groups/charter_en.pdf or in the EIP-AGRI Brochure on Focus Groups.

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www.eip-agri.eu | +32 2 543 73 48 | servicepoint@eip-agri.eu | Avenue de la Toison d'Or 72 | 1060 Brussels | Belgium