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PURE

Pesticide Use-and-risk Reduction in European farming systems with Integrated Pest Management

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Collaborative Project
SEVENTH FRAMEWORK PROGRAMME

D4.4
IPM guidelines for cabbage based farming systems in Europe

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Dissemination Level	
PU Public	**PU**
PP Restricted to other programme participants (including the Commission Services)	
RE Restricted to a group specified by the consortium (including the Commission Services)	
CO Confidential, only for members of the consortium (including the Commission Services)	

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1. Introduction

Plants of the family Brassicaceae are grown worldwide for oil, food and feed purposes. Brassicas are the most important vegetable crops in central and northern Europe. Several different species are cultivated. However cabbage plants are threatened by weeds competing for water and nutrients and are infested by a wide range of insect pests which leads to quality and crop losses and means a great challenge to *Brassica* crop production. Besides different caterpillar species, insect pests of the orders Hymenoptera, Diptera, Coleoptera und Homoptera cause severe damage in crops worldwide. In the order Homoptera especially the cabbage aphid (*Brevicoryne brassicae* (L.)) cause high damages and yield losses in the Northern hemisphere. The cabbage root fly ((*Delia radicum* L.), Diptera: Anthomyiidae) is a major pest in Europe and causes high crop losses, especially when plants are young. Control of weeds and insects require a high input of pesticides. However numerous detrimental effects on the environment, as on water, soil, human health and biodiversity can occur. Frequent pesticide use might also lead to an increase of resistances.

Integrated Pest Management (IPM) strategies have shown promises in reducing pesticide use while enabling a higher production without the mentioned problems. The aim of the project PURE is to provide integrated pest management (IPM) solutions and a practical toolbox for their implementation in key European farming systems (annual arable and vegetable, perennial, and protected crops) in which reduction of pesticide use and better control of pests will have major effects. Within the framework of the project the efficacy, practicability and relevance of IPM solutions under the agro-ecosystems and farming conditions of the main broad European regions by on-station and on-farm experiments will be tested. IPM solutions will be adapted according to regional differences and with respect to market requirements. In work package 4 partners from the UK, Denmark, France, The Netherlands, Germany, and Slovenia are involved.

In the deliverable three guidelines are comprised. The guidelines are developed for growers and advisors primarily. First, approaches to control weeds with intelligent and non-intelligent mechanical methods are depicted. Furthermore approaches to control cabbage root fly and the control of aphids and caterpillars based on control thresholds are described. The guidelines focus on different issues, such as pests, technical solutions, innovative methods, limits and conditions of success and adaptations, and sustainability.

2. Mechanical weed control in transplanted cabbages

	Field vegetables: Mechanical weed control in transplanted cabbages ***Mechanical weed control methods may replace herbicide use in transplanted white cabbage and Brussels sprouts***
	FEBRUARY 2015
OBJECTIVES	New intelligent weeding robots are now available for mechanical control of intra-row weeds growing in the crop line of transplanted field vegetables. These machines are new options in transplanted cabbage in addition to current mechanical tools working without intelligence. The purpose of the work was to study the weeding effectiveness of mechanical weed devices with and without intelligence in transplanted white cabbage and Brussels sprouts.
APPROACH (EXPERIMENTS, ASSESSMENT TOOLS, …)	White cabbage – on-station experiments in Denmark Two field experiments, one in 2012 and one in 2013, were conducted with intelligent and non-intelligent mechanical intra-row weeding in transplanted white cabbage. A herbicide treatment and a reference treatment consisting of pure manual weeding were included for comparison with mechanical treatments. The intelligent weeding device was the Danish Robovator weeder (www.visionweeding.com) that uses cameras for the detection of individual crop plants. This information is used to guide a mechanical weeding device so as to avoid crop injuries. The non-intelligent tools were finger weeding and weed harrowing. Brussels sprouts – on(experimental) farm tests in the Netherlands Three field experiments were conducted with intra-row weeding in transplanted white cabbage and Brussels Sprouts (2012 – 2014). These experiments were done on trial farms where a lot of people are visiting the trials. In the trials herbicides were compared with mechanical treatments. In 2012 the Steeketee IC Cultivator was used (using cameras). In the other years the Radis 2.0 (using a light sensor) was used.
PESTS	A very common assembly of annual weed species occurred in the Danish field experiments, notably *Chenopodium album, Tripleurospermum inodorum, Solanum nigrum, Capsella bursa-pastoris* and *Poa annua*. A very common assembly of annual weed species occurred in the Netherlands field experiments, notably *Chenopodium album, Senecia vulgaris, Capsella bursa-pastoris* and *Stellaria media*.

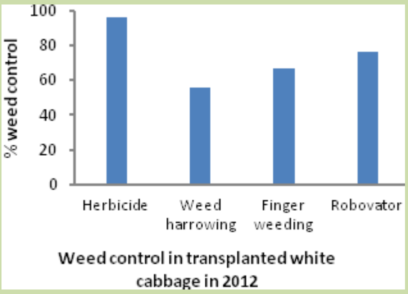
C. album T. inodorum S. nigrum C. bursa-pastoris

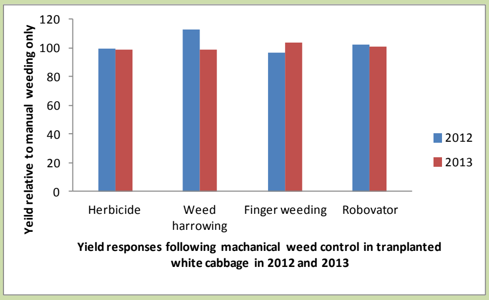
S. vulgaris S. media

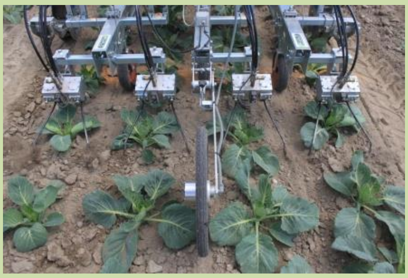
TECHNICAL RESULTS

White cabbage - the Danish results

The intelligent weeder controlled slightly more weeds than the tools without intelligence in the 2012-experiment and the effectiveness of Robovator was almost similar to the herbicide treatment. Unfortunately, there were not enough weeds to estimate the weed control effects in 2013. Either of the implements studied or the herbicide treatment caused any noteworthy injuries on the crop.



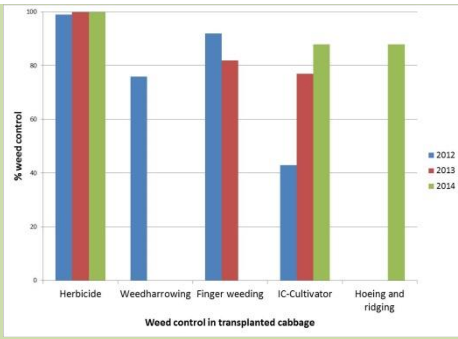




Robovator, left and right

Brussels sprouts – the Dutch results

Weed control level with the IC-Cultivator was at the same level as the non-intelligent mechanical weeding tools, except for 2012, when IC-Cultivator implementation was untimely. No yield effects were found in the experiments.



Radis 2.0

SUSTAINABILITY OF IPM SOLUTIONS

<u>DEXIPM-analyses for Danish cropping systems with white cabbage</u>

Danish cropping systems with white cabbage have 80% cereals in the crop sequence for the prevention of clubroot infestations. From a farmer perspective the **social sustainability** increases from low in current systems to intermediate in more advanced systems with the inclusion of mechanical weed control. A lower health risk due to reduced pesticide use is the main cause. **Environmental sustainability** comprises the three equally weighted attributes: resource use, environmental quality and biodiversity. The environmental sustainability increases from very low in the current system to medium in advanced systems. The use of resources improves for example by the progress in energy use caused by the reduction of pesticides. Herbicide reduction also leads to various improvements concerning biodiversity. Environmental quality improves greatly for the advanced systems. This factor is composed of the quality of water, soil and air. For example leaching of pesticide residues is less with the substitution of herbicides with mechanical tactics. The **economic sustainability** decreases from high in the current system to medium in cropping system with less reliance on pesticides. The extensive use of mechanical tactics is more prone to control failures. Economic sustainability is mainly judged on profitability (short-term sustainability) and economical viability (long-term sustainability).

<u>DEXIPM-analyses for Dutch cropping systems with Brussels sprouts or white cabbage</u>

Mechanical weed control technically is very well possible in cabbage, with conventional equipment. Intelligent intra row weeding is not particularly needed for a good result, which means such equipment is not cost-effective for cabbage growers. Hoeing with an in-row measure like finger weeders or ridging will do the job. The increased machine cost influences the **economic sustainability** of the innovative system compared with the other systems. The advanced system already has a higher labour demand, thus cost, compared with the conventional system with herbicide application. Labour demand is an important factor as farm size increases, and therefore the perceived weather risk of non-chemical measures. In general the weed control measures taken have no or limited influence on **environmental** and **social sustainability**. The increase between the advanced and innovative system can be mostly attributed to widening the crop rotation, with 50% instead of 33% cereals.

Table 1. Results of DEXiPM calculations experiments. Comparison of conventional (CON), advanced (ADV), and innovative (INN) weed control (VL = very low, L = low, M = medium, H = high, VH = very high).

Country	System	Sustainability			
		Economic	Environmental	Social	***Overall***
The Netherlands	CON	H	M	M	***M***
	ADV	M	M	M	***M***
	INN	L	H	H	***M***
Denmark	CON	H	VL	L	
	ADV	M	M	H	
	INN				

INNOVATIVE METHODS”

The two robotic weeders used in Denmark and the Netherlands have been developed from much of the expertise assembled in WP11 ‘Emerging technologies’. However, there have not been direct interactions between the manufactures of the robotic weeders and WP11 during the project period.

LIMITS AND CONDITIONS OF SUCCESS, ADAPTATIONS

Transplants of white cabbage need to be of a good quality for intelligent weeding to work properly. The stems of cabbage transplants are often bended which means that the hoe blades of the robotic weeder need to keep a safe distance from the stems, implying a less than optimal usage of the equipment. The size of this untreated zone in close proximity to the transplants determines the demand for manual weeding of residual weeds. It is essential to minimize that zone to lower the overall costs for weed control. The purchase costs for intelligent weeders are still high and need to be reduced in the future. The non-intelligent mechanical weeders can be useful but training and guidance are still required for successful employment.

REFERENCES

Melander B., Lattanzi B. & Pannacci E. (2015). Intelligent versus non-intelligent mechanical intra row weed control in transplanted onion and cabbage. Crop Protection (in press).

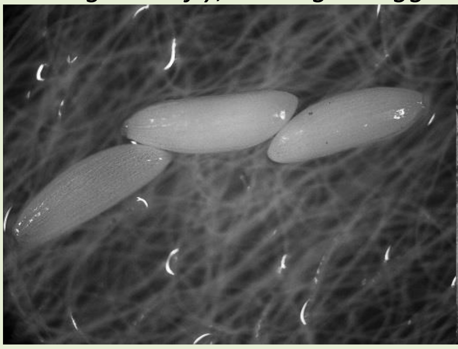
http://www.pure-ipm.eu/sites/default/files/content/files/PURE_WP4_booklet.pdf

3. Approaches to control cabbage root fly

	Field vegetables : Approaches to control cabbage root fly Cabbage root fly is difficult to control
	FEBRUARY 2015
OBJECTIVES	The cabbage root fly (*Delia radicum L.*) is a major pest Brassica crops. Larvae feeding on and in plant roots can cause severe plant damages and losses. Control is difficult and only few insecticides are authorized. Especially in organic production alternatives for cabbage root fly control are urgently needed. Within the PURE project different approaches such as entomopathogenic fungi, nitrogen lime etc. were compared with broad spectrum insecticides. Furthermore new technologies, based on volatiles, were developed.
APPROACH (EXPERIMENTS, ASSESSMENT TOOLS, …)	The general approach was to create long-term solutions that combine tactics, new technologies and production methods to reduce reliance on pesticides. A range of tools were optimized and combined to create workable IPM solutions. The strategies studied included: • Testing alternative plant protection products, such as entomopathogenic fungi and nematodes, nitrogen lime, methyl jasmonate, etc. • Investigating cabbage root fly behavior towards volatile compounds • Exploiting ecological processes with push-pull strategies

PESTS

*Cabbage root fly, cabbage maggot (*Delia radicum *L.)*



Eggs cca. 0.5 mm long.

Neonate larva.

Larva.

Larva in kohlrabi.

Pupa in kohlrabi.

Pupae in soil.

Cabbage root fly head.

Cabbage root fly.

Cabbage root fly oviposition.

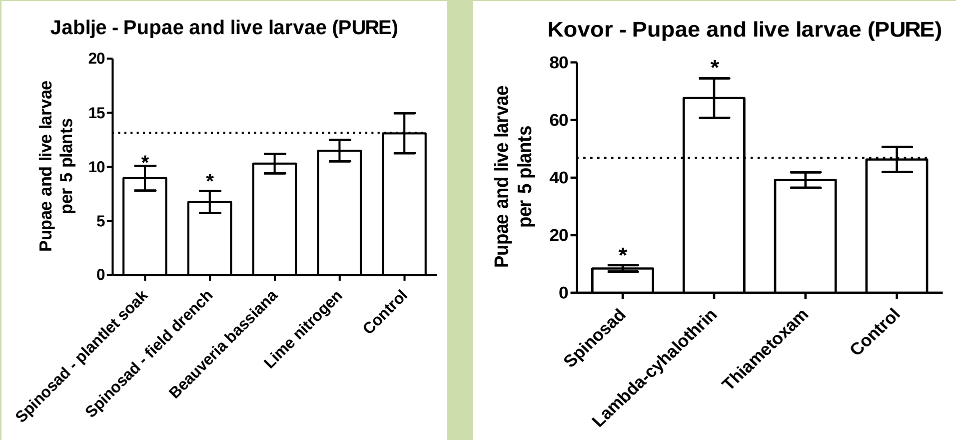
Cabbage root fly damage to broccoli.

TECHNICAL RESULTS	Results from Slovenia

TECHNICAL RESULTS

<u>Results from Slovenia</u>

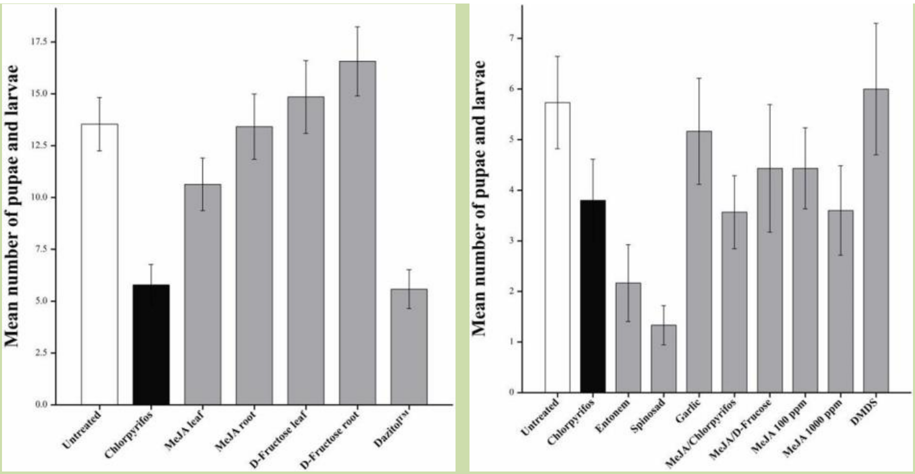
The use of biological insecticide (spinosad) resulted in a pest reduction equal to one of broad spectrum insecticides (thiametoxam). Some broad spectrum insecticides (lambda-cychalotrin) resulted in an increase of pest pressure, probably due to elimination of pest’s natural enemies. Treatments with PERLKA (lime nitrogen), Naturalis (entomopathogenic fungus Beauveria bassiana) or straw did not achieve sufficient pest control.



Number of cabbage root fly pupae and larvae per broccoli plant in the on-station trial in Slovenia.

<u>Results from Scotland (HDC funded studentship)</u>

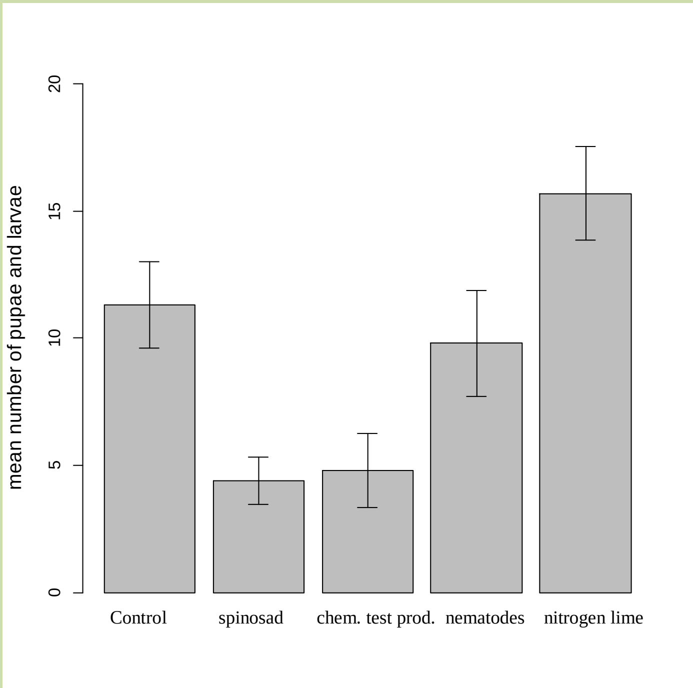
Results from on-farm field experiment 1 (2011) showed that *Chlorpyrifos* (Dursban WG) significantly reduced cabbage root fly feeding damage and the number of pupae/larvae recovered compared with untreated controls. MeJA leaf and D-Fructose leaf treatments marginally, but not significantly, reduced larval damage compared with untreated plants. Only MeJA leaf treated plants significantly reduced the number of pupae/larvae when compared with untreated plants, but numbers were still significantly higher than plants treated with *Chlorpyrifos*. MeJA leaf and root treatments inhibited plant growth and significantly reduced yield. Dazitol™ was severely phytotoxic which influenced results. Numbers of cabbage root fly pupae/larvae recovered at the end of field experiment 2 (2012) were lower than 2011. The lack of significant differences between treated and control plants for cabbage root fly larval root damage potentially reflected the low number of eggs and consequently larvae present. Despite this, results demonstrated that Entonem (*Steinernema feltiae Filipjev*), Spinosad (Tracer®), and a combination of the elicitor MeJA and reduced rate *Chlorpyrifos* showed some efficacy for controlling cabbage root fly larvae. At the concentrations tested, Garlic, MeJA on its own, DMDS (dimethyl disulfide), D-Fructose on its own and in combination, and Dazitol™ treatments were either inconsistent or reduced yield (phytotoxic) in comparison to plants treated with *Chlorpyrifos* and untreated control plants.



Number of cabbage root fly pupae and larvae on broccoli plants in Scotland 2011 (left) and 2012 (right).

<u>Results from Germany</u>

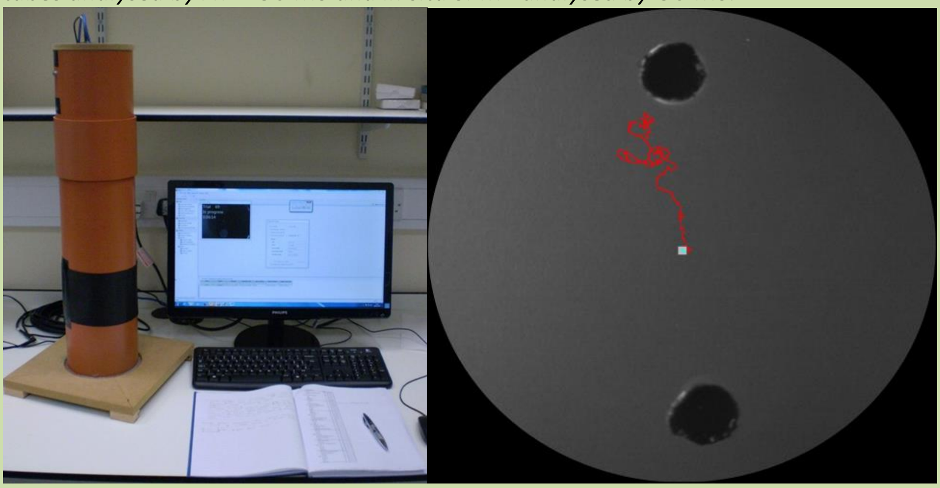
The application of spinosad and the chemical test product (not yet registered) resulted in a reduction of pupae and larvae by 50 %. Compared to the control nematodes had only slight pupae reducing properties, whereas with nitrogen lime even more pupae and larvae were found.



Number of cabbage root fly pupae and larvae on cauliflower plants in Germany in 2013.

SUSTAINABILITY OF IPM SOLUTIONS

In Denmark, France, Germany, Slovenia, The Netherlands and United Kingdom several on-station experiments were set up in countries with different growing and climate conditions. With the aim of reducing the dependency of chemical plant protection products, different IPM solutions were designed and tested for diverse Brassica crops. Therefore experiments for reducing insecticides used for controlling cabbage root fly were performed. Besides chemical insecticides, different alternative

	products (entomopathogenic nematodes and fungi, volatiles) were investigated. However those products still need further investigation under practical conditions and are at the moment too expensive for field applications.
INNOVATIVE METHODS”	A novel non-invasive laboratory/glasshouse/field in situ solid phase micro extraction (SPME)-based root volatiles collection method and EthoVision® video-tracking choice-test bioassay method were developed in Scotland. Root volatiles analysis revealed marked differences in the emission rates of volatile compounds detected before and after mechanical and cabbage root fly larval feeding damage. EthoVision® bioassay results revealed that newly hatched cabbage root fly larvae were significantly attracted to host plant root volatiles. A major volatile constituent of broccoli roots, DMDS, was attractive to larvae, but toxic at the highest dose tested.  *Root volatiles collection from glasshouse- and field-grown broccoli plants using Tenax TA tubes analysed by ATD-GC-MS and in situ SPME analysed by GC-MS.*  *EthoVision® video-tracking method and cabbage root fly larval tracks.* In France the response of insects towards plant volatiles (DMDS, hexenyl acetate) was tested in the field. DMDS strongly decreased egg laying in the field while hexenyl acetate increased it. These two coumpounds would be interesting to consider in a push pull approach. DMDS is also attractive to predators such as staphylinids and carabid beetles and could be used to enhance natural control of the fly
LIMITS AND	Current recommendation to farmers is the drench of plants with spinosad

CONDITIONS OF SUCCESS, ADAPTATIONS	shortly before planting. Despite the positive results, in some countries (Slovenia) this substance is not registered for cabbage root fly control. Therefore action is needed to facilitate the registration process to enable such pest control. Additionally, more research is needed to find alternative products for cabbage root fly control, as some reports exist that spinosad can harm non-target organisms.
REFERENCES	RAZINGER, Jaka, LUTZ, Matthias, SCHROERS, Hans-Josef, UREK, Gregor, GRUNDER, Jürg M. Evaluation of insect associated and plant growth promoting fungi in the control of cabbage root flies. Journal of economic entomology, 2014, 107, 1348-1354. RAZINGER, Jaka, LUTZ, Matthias, SCHROERS, Hans-Josef, PALMISANO, Marilena, WOHLER, Christian, UREK, Gregor, GRUNDER, Jürg M. Direct plantlet inoculation with soil or insect-associated fungi may control cabbage root fly maggots. Journal of invertebrate pathology, 2014, 120, 59-66, doi: 10.1016/j.jip.2014.05.006.

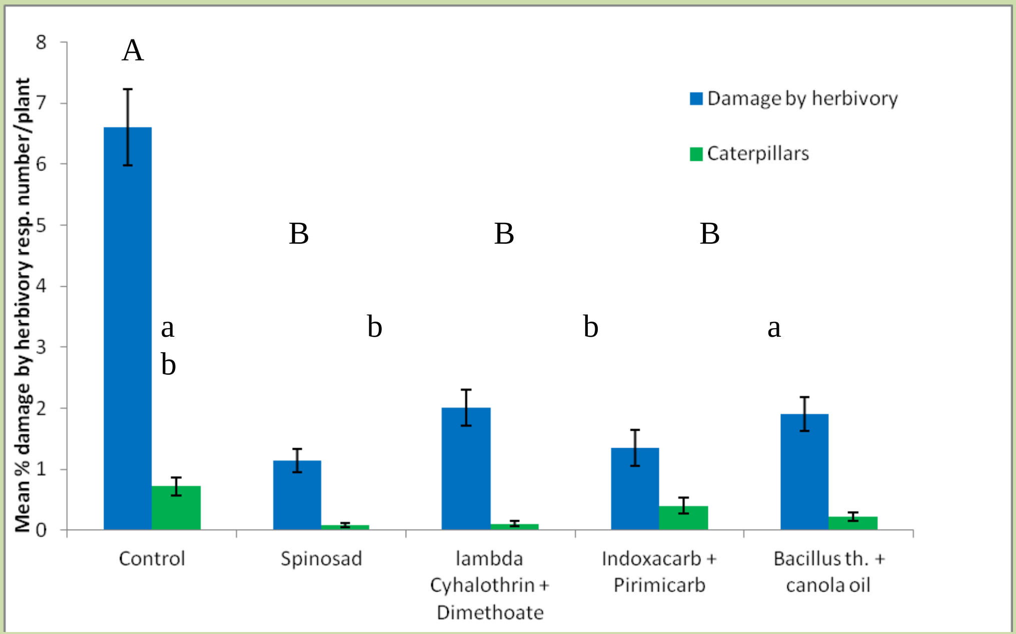
4. Supervised control of caterpillars and aphids according to control thresholds

	Field vegetables: Supervised control of caterpillars and aphids according to control thresholds **Supervised control helps reducing insecticides**
	FEBRUARY 2015
OBJECTIVES	On cabbage crops several different pest species request an intensive plant protection. In the framework of the PURE project experiments were run to get information about the efficacy of different insecticides and contribution to pesticide reduction. Here, broad spectrum insecticides were compared with selective insecticides and biological ones. One focus was laid on supervised control of caterpillars (mainly cabbage moth (*Mamestra brassicae*), cabbage white butterfly (*Pieris rapae*) and diamond back moth (*Plutella xylostella*)) and cabbage aphids (*Brevicoryne brassicae*) according to control thresholds. Based on regular monitoring control of insect pests after control thresholds are exceeded is a successful tool in reducing insecticide applications. Control thresholds need to be adapted to the particular farm conditions and production aims.
APPROACH (EXPERIMENTS, ASSESSMENT TOOLS, …)	Two on-station experiments were conducted in white cabbage in 2012 and 2013, respectively. Thereby broad spectrum (lambda-cyhalothrin (Karate Zeon®) against caterpillars, dimethoate (Perfekthion®) against aphids), selective (indoxacarb (Steward®) against caterpillars, pirimicarb (Pirimor®) against aphids) and biological insecticides (spinosad (SpinTor®) against caterpillars, Bacillus thuringiensis ssp. aizawai (XenTari®) against caterpillars and rape oil (Micula®) against aphids) were compared to untreated plants. Fifty plants of each treatment were monitored weekly and treated fortnightly if control thresholds were exceeded. Control thresholds of on-station experiments were 20% infested plants with less than 100 cabbage aphids or 10% infested plants with more than 100 cabbage aphids. For caterpillars it was dependent on cabbage growth stage: 25% infested plants until 8-leaf stage, 50% infested plants from 9-leaf stage to start of head building, 5% infested plants during head performance until harvest. In accordance with growers thresholds for on-farm trials were simplified. Here, 25 plants of each treatment were monitored weekly and treated fortnightly if control were exceeded.
PESTS	In North and Central Europe main leaf insect pests in cabbage growing are caterpillars such as cabbage moth (*Mamestra brassicae*), cabbage white butterfly (*Pieris rapae*) and diamond back moth (*Plutella xylostella*) as well as aphids (*Brevicoryne brassicae*).  *B. brassicae* *M. brassicae* *P. rapae* *P. xylostella*

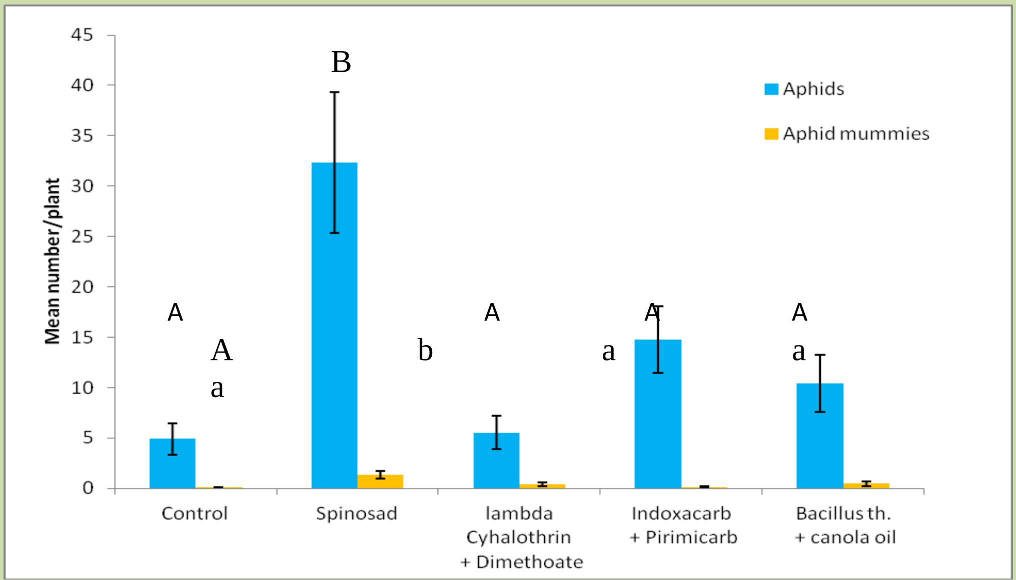
TECHNICAL RESULTS

Insect pest infestation was very low in the last years. At harvest all plant protection products reduced the number of caterpillars as well as damage by herbivory considerably.

In 2012 numbers of aphids at harvest were lowest in the untreated control. Higher numbers of aphids and parasitized aphids were found on plants treated with plant protection products and especially when spinosad was used against caterpillars. This result could indicate that insecticides may harm aphid predating insects. However this finding needs to be confirmed.



Mean percentage of damage by herbivory as well as number of caterpillars (± SE) per white cabbage plant in relation to different treatments at harvest in 2012 (n=50, Tukey HSD Test, α=0.05).



Mean number of aphids and aphid mummies (± SE) on white cabbage plants in relation to different treatments at harvest in 2012 (n=50, Tukey HSD Test, α=0.05).

White cabbage field in 2012

SUSTAINABILITY OF IPM SOLUTIONS

During on-farm trials in 2014 insecticides were sprayed 10 times on the conventional part of the field compared to five applications on the field sprayed only when thresholds were exceeded. On conventional fields two more treatments were applied against caterpillars, one against aphids and two against thrips. Data about cost-benefit-efficacy are not yet available since cabbage heads are still in the cold warehouse.

As example data, spraying data from 2014 were assessed with SYNOPS. Table 1-4 shows that by choosing biological or selective insecticides rather than broad spectrum insecticides and by using spraying less often, the risk on different aquatic and terrestrial and non-target organisms is reduced. Therefore, regarding the complete strategy, spraying after action thresholds are exceeded and using selective or biological plant protection products is a good way to minimize the risk on the environment and especially aquatic organisms.

Table 1. Risk potential of the different insecticide sprays against aphids and caterpillars for acute effects on aquatic, terrestrial, non-target organisms and groundwater in Germany.

	aquatic						terrestrial		non-target organism	Groundwater
	Aquatic	Algae	Daphnia	Fish	Lemna	Chironomus	Terrestrial	Earthworm	Bee	
complete strategy	0,623091	0,000688	0,623091	0,358277	0,000083	0,452894	0,320556	0,015361	0,320556	0
alpha-cypermethrin	0,275342	0,000688	0,275342	0,051627	0	0	0,027166	0,00006	0,027166	0
dimethoate	0,001792	0,00004	0,001792	0,000119	0	0	0,14247	0,015361	0,14247	0
lambda-cyhalothrin	0,623091	0,000119	0,623091	0,358277	0	0,095541	0,004339	0,000014	0,004339	0
pirimicarb	0,167562	0,000014	0,167562	0,000032	0	0,000168	0,010139	0,001284	0,010139	0
spinosad	0,000117	0,000013	0,000063	0,000117	0,000083	0	0,320556	0,000065	0,320556	0
thiacloprid	0,452894	0,000028	0,000012	0,000046	0,000009	0,452894	0,001234	0,000363	0,001234	0

Acute risk	very low risk	low risk	medium risk	high risk
	ETR<0.01	0.01<ETR<0.1	0.1<ETR<1.0	ETR>1.0

Table 2. Risk potential of the different insecticide sprays against aphids and caterpillars for chronic effects on aquatic, terrestrial, non-target organisms and groundwater in Germany.

	aquatic						terrestrial		non-target organism	Groundwater
	Aquatic	Algae	Daphnia	Fish	Lemna	Chironomus	Terrestrial	Earthworm	Bee	
complete strategy	59,71184	0,000866	59,71184	2,469489	0,00069	1,384257	1,428681	0,074171	1,428681	0
alpha-cypermethrin	2,203779	0,000661	2,203779	2,203779	0	0	0,162127	0,000296	0,162127	0
dimethoate	0,06564	0,00008	0,06564	0,006564	0	0	0,139571	0,064604	0,139571	0
lambda-cyhalothrin	56,92513	0,000113	56,92513	0,450847	0	0,867014	0,038296	0,000166	0,038296	0
pirimicarb	1,937315	0,000035	1,937315	0,000121	0	0,000174	0,077791	0,012279	0,077791	0
spinosad	0,849391	0,00017	0,849391	0,000609	0,000689	0	1,312594	0,000066	1,312594	0
thiacloprid	0,678236	0,000057	0,000068	0,001404	0,000014	0,678236	0,009492	0,009492	0,001217	0

Chronic risk	very low risk	low risk	medium risk	high risk
	ETR<0.1	0.1<ETR<1	1<ETR<10	ETR>10

Table 3. Risk potential of the different insecticide sprays against aphids and caterpillars for acute effects on aquatic, terrestrial, non-target organisms and groundwater in Germany.

	aquatic						terrestrial		non-target organism	Groundwater
	Aquatic	Algae	Daphnia	Fish	Lemna	Chironomus	Terrestrial	Earthworm	Bee	
complete strategy	0,167562	0,003145	0,167562	0,000519	0,004151	0,000168	0,320556	0,001284	0,320556	0
indoxacarb	0,004151	0,003145	0,000692	0,000519	0,004151	0	0,023419	0,00002	0,023419	0
pirimicarb	0,167562	0,000014	0,167562	0,000032	0	0,000168	0,010139	0,001284	0,010139	0
spinosad	0,000117	0,000013	0,000063	0,000117	0,000083	0	0,320556	0,000065	0,320556	0

Chronic risk	very low risk	low risk	medium risk	high risk
	ETR<0.1	0.1<ETR<1	1<ETR<10	ETR>10

Table 4. Risk potential of the different insecticide sprays against aphids and caterpillars for chronic effects on aquatic, terrestrial, non-target organisms and groundwater in Germany.

	aquatic						terrestrial		non-target organism	Groundwater
	Aquatic	Algae	Daphnia	Fish	Lemna	Chironomus	Terrestrial	Earthworm	Bee	
complete strategy	2,788597	0,022624	2,788597	0,00206	0,029837	0,000174	1,3904	0,012348	1,3904	0
indoxacarb	0,029837	0,022604	0,003978	0,001989	0,029837	0	0,071151	0,000028	0,071151	0
pirimicarb	1,937315	0,000035	1,937315	0,000121	0	0,000174	0,077791	0,012279	0,077791	0
spinosad	0,849391	0,00017	0,849391	0,000609	0,000689	0	1,312594	0,000066	1,312594	0

Chronic risk	very low risk	low risk	medium risk	high risk
	ETR<0.1	0.1<ETR<1	1<ETR<10	ETR>10

INNOVATIVE METHODS"

Some participants of WP4 also contributed to WP13 "Co-innovation of IPM". Here trials were conducted together with growers on commercial farms. The overall aim was to build a bridge between research and farming practice. Results from on-farm trials showed that the reduction of pesticide use is basically possible. However control thresholds have to be adapted to the respective farm.

LIMITS AND CONDITIONS OF SUCCESS, ADAPTATIONS

Spraying plant protection products after control thresholds are exceeded is a very good option for reducing the amount of insecticides. Biological and selective insecticides performed as well as broad spectrum insecticides.
However an adaption of thresholds is needed to the respective farm due to occurrence of insect pests, environmental conditions, production goals and market demands. Furthermore the establishment of control thresholds for all pests of one crop is important.

REFERENCES

Links with deliverables and reports on the PURE website
http://www.pure-ipm.eu/

5. Conclusions

Mechanical weed control in transplanted cabbages

Intelligent and non-intelligent mechanical weeding devices were compared with herbicide treatments. Robotic weeders as intelligent weeding devices are proven to be a successful tool for controlling weeds on cabbage fields. A disadvantage is their high price. Other mechanical weeding methods (finger weeding, weed harrowing) showed results comparable to the intelligent weeder. However weather conditions play an important role, as mechanical weeding is not possible on very wet fields. Cabbage plants must have a good quality without any bended stems to use the mechanical weeding devices reasonable.

Approaches to control cabbage root fly

Experiments with different insecticides as well as alternative products, such as nitrogen lime, entomopathogenic fungi and nematodes, and plant volatiles (MeJa and DMDS) were performed on fields. Current recommendation to farmers is the drench of plants with spinosad shortly before planting. Additionally, more research is needed to find alternative products for cabbage root fly control, as some reports exist that spinosad can harm non-target organisms.

Supervised control of caterpillars and aphids according to control thresholds

Control thresholds for caterpillars and aphids were tested on-station and on-farm. Results showed that spraying insecticides according to thresholds is a method to reduce insecticide sprays. Different insecticides (broad spectrum, selective, and biological insecticides) were applied. Aphids and caterpillars were controlled with all insecticides used. An adaption of thresholds is needed to the respective farm due to occurrence of insect pests, environmental conditions, production goals and market demands. Furthermore the establishment of control thresholds for all pests of one crop is important.