

Open field vegetable production in Croatia

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Croatia has favourable natural conditions and a long tradition of open field vegetable production. The open field vegetable production is concentrated on some spots in Croatia. The production is very variable in intensity of production and grown crops. The variability is result of the great difference in climate conditions and soil types in different part of the country. Main open field vegetable production is concentrated in two main areas. One is in the Mediterranean and other one in the Continental part of Croatia. These two areas are separated by mountain chains which have basic effect on climate conditions and open field vegetable production. The third area is the Mountain part which is known on cabbage and potato production.

The total open field vegetable production without potato was in the year 2008 on the 12.942 ha and total production was 201.585 tones, according to Crostat. Organic open field vegetable production out of the total was in the year 2008 on the 95 ha and total production was 250,2 tones, according to Ministry of Agriculture, Fisheries and Rural Development. In the Mediterranean part of Croatia the production is concentrated in the river valleys and karsts fields. The largest valley is Neretva and the prevalent production is production of cabbage, watermelons and melons. The largest production of processing tomato is on the Istrian peninsula.

The prevalent production in the Continental part of Croatia is cabbage, cucumber and pepper for processing industry. The main open field production for fresh market is production of vegetables cultivated for fruit, leafy and root vegetables.

Syngenta experience in different application methods of insecticides against soil pests

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Syngenta development organization in Europe is divided in 5 development units. This concept is created to capture as much as possible the innovative solutions and meet the differences of European regions in order to comprise their environmental, regulatory and practical needs.

In Syngenta portfolio there are 2 basic active ingredients used against soil insects in vegetables and other crops prone to be attacked by this group of harmful organisms. Thiametoxam as systemic a.s. and tefluthrin as contact a.s. with vapour effect in the soil. Both a.s. have very wide label regarding on pests and crops, but also with regards to different application methods.

As any other aspect of chemical plant protection, application methods were evolved and are changing constantly according to the changes in agricultural, economical and environmental aspects of cropping system

In the presentation we would like to give a short overview of positive and negative aspects of different modes of application (microgranulators, microgranulator spot application, tray dip or drench of young transplants, post-transplanting application by drip irrigation system, classical seed coating, seed treatment by phytodrip) identified during the commercial use or development phase of our products used for suppression of soil insects.

Current research on entomopathogenic nematodes in Slovenia with the aim to control vegetable pest insects

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In Slovenia, we started with first researches on entomopathogenic nematodes (EPNs) in 2004. Due to the status of exotic organisms which EPNs had till 2008, all till then performed researches were limited to laboratory experiments. The aim of our investigations was to examine the activity of different species of EPNs at different temperatures and different concentrations of suspension against some vegetable insect pests (*Eurydema ventrale*, *Phyllotreta* spp.). Between 2006 and 2009 we were actively involved in studying the EPNs presence and abundance in Slovenian soils and in totally 520 analysed samples we confirmed above mentioned biological agents in 24 samples. For the time being we have evidence of existence for 5 species of EPNs; *Steinernema affine* (Bovien), *S. feltiae* (Filipjev), *S. carpocapsae* (Weiser), *S. kraussei* (Steiner) and *Heterorhabditis bacteriophora* (Poinar). The list of indigenous species of organisms for the purposes of biological control in Slovenia at the moment includes the last four species of EPNs. At the moment, for commercial purposes 7 products with EPNs as active ingredient are allowed to be used in Slovenia. Unfortunately none of them is registered for controlling field vegetable insect pests.

Biological control through selective biodiversity and targeted crop rotation

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We are investigating a system where two key pests of cabbage and onion (*Delia radicum* and *D. antiqua*) [Diptera:Anthomyiidae] are controlled using 1) crop rotation to disrupt the lifecycles and 2) semi-permanent selective flower/grass strips to enhance the parasitoid *Trybliographa rapae* [Hymenoptera: Figitidae] and soil inhabitant generalist predators. *T. rapae* attacks both *Delia* pests and, therefore, is not disrupted by the crop rotation which provides a less disturbed system. Semi-permanent flower/grass strips will provide nectar

resources and our hypothesis is that increased supply of nectar and shelter can be translated into an increased pest regulation. The flower/grass strips can also be used as overwintering sites for natural enemies. This will enable stable populations of the parasitoid and general predators.

We have evaluated different plants with respect to their potential role as nectar resources for both the herbivore and the parasitoid. Flower attractiveness was tested in a two-choice olfactometer and nectar utilization was tested in cages where the insects were introduced to flowering plants for 3 and 6 hours and then weighted. We also assessed the longevity of both insect species on four different nectar plants.

Our results indicate that *T. rapae* is attracted to and can utilize nectar from dill (*Anethum graveolens*), buckwheat (*Fagopyrum esculentum*) and sweet alyssum (*Lobularia maritima*). Common borage (*Borago officinalis*), coriander (*Coriandrum sativum*) and chamomile (*Matricaria chamomilla*) were both unattractive and were not utilized as nectar resources. *D. radicum* were attracted to sweet alyssum (*Lobularia maritima*) and dill (*Anethum graveolens*), but slightly repelled by buckwheat (*Fagopyrum esculentum*). The nectar could however be utilized from all three plant species. Provision of nectar significantly increased the longevity for both insect species, and the further effect of nectar on parasitisation efficiency for *T. rapae* is now being evaluated.

Large scale demonstration of exclusion fences for management of cabbage fly, *Delia radicum*: Opportunities for IPM?

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Abstract: In previous studies, it was shown that low-flying dipteran pests, including the cabbage maggot fly, *Delia radicum* (L.); the onion maggot fly, *D. antiqua* (Meigen); the seed corn maggot fly, *D. platura*; and the carrot rust fly, *Psila rosae* (F.), could be impeded from entering their host crops by erecting screen fences around the field perimeters. Exclusion fences 0.9m in height with downward-sloping screen overhangs about 25cm long prevented >80% of cabbage fly females from entering 5 x 5 m enclosed plantings of rutabaga, and associated maggot damage was also significantly reduced relative to unfenced controls. In another study, cabbage fly females captured inside a larger, 38 x 38 m fenced enclosure containing radish were 90% fewer than in an unfenced adjacent area of equal size. In theory, the number of female cabbage flies able to fly over each meter of an exclusion fence would increase proportionately according to the overall length of the fence. In the case of a square, 1 ha fenced field of rutabagas, cabbage flies would enter the field along a 400 m fenced perimeter, and would then have access to 10,000 m² of rutabagas. If the length of fence on all sides were doubled (now an 800 m fenced perimeter), the number of flies entering the field would be roughly doubled, but they would now have access to 40,000 m² of rutabagas. Therefore, cabbage fly females per unit area and the ensuing damage to individual rutabagas should decrease as the area enclosed by an exclusion fence increases. This principal is discussed in the present paper, which reports on yellow sticky trap (*D. radicum* and *D. platura*), egg count and maggot damage surveys conducted in large-scale fence-enclosed fields versus open fields of rutabagas in the lower Fraser Valley of British

Columbia in 2009. The implications of these findings in designing new IPM programs for dipteran pests of cruciferous crops are also discussed.

The spatial distribution of a root fly in a barrier protected crop.

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We report initial findings of an investigation into the effectiveness of a fence barrier in reducing ingress of *Delia radicum* flies into a field of rutebega, and subsequent patterns of oviposition and plant damage. Details of the study site are reported elsewhere (see Vernon et al, this meeting). We observed a 98% reduction in the number of flies caught on yellow sticky traps within the fenced crop compared with outside the fence. There was also a change in the sex ratios of catches with a reduction in the proportion of males recovered inside the field. Data analyses of trap counts within and outside the fenced area using GLM methods showed that for both sets of data there were significant differences in catch between sampling dates, trap locations and also the two sides of the traps. Spatial patterns of trap catches showed that female *D. radicum* were largely restricted to areas adjacent to the fence. Similar patterns were discerned for oviposition and damage to plants.

Exclusion Fences Revisited

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In order to produce marketable brassica crops in most regions in Norway, it is necessary to protect the crop from the cabbage root fly, *Delia radicum*, and the turnip fly, *D. floralis*. There is currently one insecticide, dimethoate, registered for control of these pests. A spinosad-based product has an off-label registration. In organic production, and in most cases in integrated production the only reliable method for protection against these pests is to cover the crop with insect netting or similar row covering. While this method is very effective, the covers are expensive, they need to be removed for weed control, and the reduced light, increased humidity and higher temperature can reduce the quality of the product.

Exclusion fences modelled after the research prototypes reported by Vernon and colleagues from Canada were tested over several years in Norway. The results from these studies were reported at the IOBC Working Group meeting in 2003. Since that time exclusion fences have been used by a small number of growers for protection against the *Delia* flies, especially in swede crops. A series of experiments in the period from 2004-2007 gave variable results,

which led to speculation that the fences were more effective in flat terrain and at a distance from tall vegetation. Studies on the flying height of the flies in the field indicated that terrain and height of surrounding vegetation were not significant factors, whereas height of vegetation in the immediate vicinity of the fence was important. Follow-up studies on flying height were initiated in 2009. Preliminary results from these studies will be presented.

Fences using netting impregnated with insecticide have been developed and are now registered for use in Norway. Due to the current lack of effective insecticides, these fences are becoming increasingly popular and in some regions they are the dominant means of controlling root flies in brassicas. There are reports of little or no damage from the root flies in regions that have extremely high populations every year.

Investigations on root fly control in Germany

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Summary

Several experiments on the control of cabbage root fly (*Delia radicum*) and carrot fly (*Psila rosae*) were conducted on the field stations of the institute in 2008 and 2009. Spraying in short intervals during flight activity against the adults and using film coated seeds to control the larvae were investigated as control measures. Furthermore, the setting up of vertical fences to prevent root flies from attacking the crop was tested again in 2009.

Among the tested insecticides seed coating with chlorpyrifos still showed the highest efficacy against cabbage root fly and carrot fly. Spraying with spinosad in weekly intervals during flight activity obtained promising results. The attempt with vertical fences failed again to give an adequate control of root flies.

Effects of intercropping on the life cycle of the turnip root fly (*Delia floralis*)

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The turnip root fly (*Delia floralis*) is a pest insect in the northern temperate regions of the world. If uncontrolled, it can cause severe problems in the production of brassica crops. Field trials and laboratory studies were performed to examine how intercropping of cabbage (*Brassica oleracea*) and red clover (*Trifolium pratense*) affects the different life cycle stages of *D. floralis*.

A field trial was performed in Umeå, northern Sweden), to study the effects of intercropping on *D. floralis* oviposition behaviour, and the impact of predators and parasitoids on *D. floralis* in the field. Intercropping was found to reduce *D. floralis* oviposition compared with monoculture. Furthermore, analysis of the spatial distribution of eggs within plots showed that the difference in egg numbers was greatest close to the border between the cultivation systems. Natural enemies, in this case mainly predators, significantly reduced the final pupal numbers of *D. floralis* but this effect did not differ between the cultivation systems. However, the study showed that it is possible to retain the predation pressure in intercropped systems despite lower predator activity-densities and *D. floralis* egg numbers.

A greenhouse experiment was performed to investigate effects of intercropping on development of *D. floralis* at different larval and intercropping densities and to analyse different aspects of host plant quality in the same system. It was found that *D. floralis* pupal weight decreased in response to both intercropping and larval density. This impaired larval development is likely to be explained by changes in host plant quality, which included decreased biomass, lower root nitrogen levels, higher root fibre content and altered glucosinolate concentrations.

Control of cabbage root fly (*Delia radicum*) with the predatory staphylinid beetle *Atheta coriaria*

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Abstract: The predatory staphylinid beetle, *Atheta coriaria*, was investigated as a potential biological control agent for cabbage root fly (CRF) (*Delia radicum*). Initial predation bioassays confirmed that *A. coriaria* adults eat both CRF eggs and young larvae. Subsequent work demonstrated that it was possible to 'seed' modules with *A. coriaria* in the propagation glasshouse. By adding an artificial food source (turkey-rearing crumbs) to the compost, *A. coriaria* colonised and bred in modules during the propagation period. Modules prepared in this way were then used in a semi-field experiment to test whether the *A. coriaria* in the modules could reduce the severity of CRF damage to cauliflower plants once planted out. CRF eggs were added to the soil around each plant over a 2-week period, to simulate second generation CRF egg laying. Significantly less CRF root damage was recorded in plants where beetles had been reared in modules during propagation compared with untreated control plants. Similarly, plants treated with high numbers of beetles after planting out also had significantly less damage than control plants. The efficacy of *A. coriaria* used either to 'seed' modules during propagation or applied to plants after planting out was tested in the field in 2009. Results compared *A. coriaria*-treated plants to modules drenched with chlorpyrifos or spinosad as well as untreated control plants. More untreated control plants died as a result of CRF feeding and root weights of surviving plants were lower compared with *A. coriaria* or insecticide-treated plants. The number of plants dying as a result of CRF feeding, and root weights of surviving plants were similar in both *A. coriaria* and insecticide treatments. However, root damage index assessments did not differ significantly between treatments. Although further work is required, results so far indicate that *A. coriaria*, applied to modules during propagation or after planting out has potential for cost-effective biological control of CRF.

Key words: *Atheta coriaria*, cabbage root fly, *Delia radicum*, biological control.

Changes of phenology and pest status of northern *Agrotis segetum* under the new climatic conditions.

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Cutworm, the larva of the Turnip moth (*Agrotis segetum* Schiff.) is known as a strongly varying pest species in NW Europe. Monitoring by sex pheromone trapping is a vital part of pest management, including rather detailed forecasting in some countries. In Denmark the number of involved sites has varied over years but the monitoring methodology has been unchanged since 1981. Therefore it is possible to trace some phenological changes in response to the gradually warmer climate and suggest explanations to the apparent changes of the pest status over the last decade.

Due to the rising summer temperatures the median of the trapping (flight) period is now approximately 10 days earlier than in the 1980'es, and the previously negligible second generation of moth may be as big as the first generation. In Denmark and southern Sweden the earlier mean flight period in combination with higher risk of dry periods in summer increases the risk for serious attacks of cutworms. However, the second moth generation is a loss for the population to be present the following year. In addition the climate change also involves increased probability for extreme precipitation events. If several very rainy days coincide with the presence of the youngest cutworms, they will suffer high mortality. The end result of these contradictory possibilities is increased variation, geographically as well as between years, and hence a more difficult forecasting situation.

Okra cultivation in Zagreb County according to the principles of integrated production of vegetables

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The constantly increasing demands of the domestic market for new agricultural products have provided an incentive to Croatian agricultural producers to expand the range of their own production. Thus okra (*Hibiscus esculentus*), a vegetable crop originating in eastern Africa, has found its place in the vegetable production in the area of Zagreb County. In comparison with other vegetable crops which are cultivated in the open, okra exhibits a certain resistance to diseases and pests. Its cultivation can easily be included into the principles of integrated production of vegetables, which is gradually being accepted in Croatian agricultural production.

In the area of Vrbovec, a town in Zagreb County, during 2008 and 2009 the cultivation of this oriental vegetable crop was closely observed. Microclimatic conditions have been favourable

to the cultivation of crops of 1 hectare area. The cultivation incorporated the preparation of soil in autumn, during which, besides deep ploughing, stable manure was used in the quantity of 40 tons per hectare. Seed sowing was carried out at the end of May in the open area in the rows spaced 25cmx80cm. Spring mineral nutrition consisted of combined mineral fertilizer NPK 12:12:12. During the cultivation of okra the main problem was caused by weeds, while only during the first year a small amount of plants exhibited *Phytophthora* sp. Pests in this crop did not have a significant unfavourable effect. Also, there were no root nematodes, frequent pests found on okra throughout the world, against which the integrated production recommends the application of root and leaf extract of *Leucaena leucocephala* i *Gliricidia sepium* plants. During cultivation, weeding was done two times. The harvest lasted throughout August till the beginning of September in both seasons of okra cultivation. The yield per hectare in the first year was 2 tons, and in the second year 2.5 tons.

The guaranteed crop purchase for the needs of food industry requires dried okra, while current increasing needs of purchasers call for the extended production of this interesting vegetable crop. If we also take into consideration the demands of domestic consumers which consume imported okra, it can be easily concluded that this oriental vegetable crop is suitable for cultivation in small family farms and that it also offers to potential producers favourable production conditions in the wider area of continental Croatia.

Integration of several methods to reduce the impact of pesticides in outdoor vegetable production: a practical approach

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Reduce the quantity of pesticides in practice, how can we reach that? That was examined on several fields of growers in Flanders by means of two demonstration projects. Band spraying - an alternative more efficient spraying technique, an appropriate choice of pesticides used and treatments based on warning systems and warning messages were essential to achieve a lower pressure on the environment. The sum of all these measures were summarized into one value, the POCER and later on, the PRIBEL indicator: the lower the score value, the lower the pressure on environment and health.

It was clear that band spraying was very successful, especially in leek crops. When the plants are young, the spraying area and so the quantity of used plant protection products, is much lower compared with a full field treatment. Depending on the growth of the plants, bandwidth of the spraying boom should be widened. From the moment there is leaf touch of plants between the rows, full field treatments are necessary. The disadvantage of this technique is that there is currently a lack of appropriate mechanization or no practical application. On a classic spraying machine, the nozzles are placed at a fixed distance of 50 cm; so only four rows at once can be treated. For application in practice, it is necessary to achieve a bigger spraying width like now operable on farms. Also, the spray boom must be very stable to avoid variations in height. In the future, a spray boom driven by GPS techniques would allow to increase spraying width, using intersections of 4 rows. In addition and where possible, the use of pesticides with low PRIBEL value can give an additional reduction of pesticides pressure. Although, the possibilities are rather limited since in many vegetable cultures, there are not so much pesticides available.

Control of the cabbage white fly (*Aleyrodes proletella*)

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Since the warm summer in 2006, Swiss growers have reported problems with the control of white flies in cole crops. They blame the registered pesticides for achieving inadequate control levels and suppose that the pest has developed insecticide resistance. On the other hand, consultants require an improved monitoring method, especially since growers start with the treatments often too late.

In 2009, we tested yellow sticky traps ('REBELL® giallo') for the monitoring of adult white flies in Brassica crops. However, trap catches were registered simultaneously or later in comparison to the infestation of the crop. Due to a high number of insignificant insects caught, the identification of the white flies on the trap seems to be too difficult for growers. Therefore, crop inspection is highly recommended.

Furthermore, we compared in another study the efficacy and the insecticidal duration of registered and novel insecticides. These were applied as sprayings against white fly larvae, adults and eggs respectively in a Savoy cabbage crop. According to our preliminary results spirotetramat was the most effective treatment compared to pymetrozine, methomyl, flonicamide and thiacloprid. It seemed to have a long suppressing effect on the cabbage white fly and on the peach aphid (*Myzus persicae*).

A crop protection strategy and the significance of crop adapted spraying is discussed.

Integrated Pest Management in Great British Vegetables

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Abstract: British vegetable producers rely on crop protection products to produce high quality vegetables at a competitive price. IPM strategies are used to ensure that pesticide use is optimized and environmental impacts are minimized. Key challenges facing the sector are the changes to regulations regarding the registration of plant protection products at an EU and National level (EU Directives for pesticide registration and Sustainable Use Directive), both coming into force in October 2011 and particularly affecting pesticides classed as 'endocrine disruptors.' In the UK we have a second tier of unofficial 'legislation' from our supermarket customers, with various targets to reduce and eliminate pesticide residues. Public (not scientific) perception is that pesticide residues are bad and thus should not be used. Pesticide residue detection threshold levels are reducing (currently testing to 0.01mg/kg), and new tests are coming on stream. Despite this we are achieving good progress in residue reduction. For example carrots and parsnips from our business have

tested residue-free for the last 3 years. Various supermarket and industry initiatives are driving this change.

The research agenda is also responding to this demand, with more calls for IPM strategies, including exploration of biopesticides. A recent 'gap analysis' is being used to influence new screening work which has traditionally focused primarily on conventional pesticides. There is a new EU Call for IPM in farming systems research (up to 9M Euros) and a meeting to discuss EU funding of an EU minor use programme. UK government has just announced a budget of 14 M Euros for new approaches to crop protection.

On farm we are using pest monitoring systems and information, eg. Brassica Alert (disease and pests), Yellow sticky traps (Brassicacae and carrots), blue sticky traps (leeks), crop walking and Warwick HRI's Pest Bulletin for aphids.

The possibilities of protection organic cabbage crops in Poland

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Abstract

In Poland there are a strict law regulations limiting the availability of plant protection products (PPPs) to organic farming. At present, only 32 PPPs are qualified for use in organic farming. Among them, 17 are registered to protect of vegetables and horticulture crops, generally. There is only 1 insecticide, 14 fungicides - bactericides and 2 plant products purposed to dressing seeds (not available for individual growers). For cabbage crops are purposed 5 products and it is a main reason that in Poland the cabbage growing is very difficult and the research are conducted towards seeking of new possibilities of protection. In this study is involved the review all the permitted PPPs to organic vegetable crops in Poland.

In next part of paper, will be presented the results of insecticidal efficacy of spinosad (0.2%), neem (0,5%), the rape oil (0.1%) and the garlic extract (2%) in the cabbage field. The treatments were applied 2 times with 7 days apart. The presence and the percentage of defoliation due to feeding insect pests were assessed. In the experiment were observed the caterpillars of *Pieris brassicae*, *P. rape*, *Mamestra brassicae*, and the colony of aphid *Brevicoryne brassicae*. The degree of effectiveness was related to the reduction of leaf consumption and consequently to the increasing of the yield. Spinosad and neem treatments delivered the best protection. The application of the rape oil and the garlic extract applied separately were insufficient to protection of plants. In mentioned combinations is needed much more treatments.

A microbial protection was involved into cabbage growing also. The trade product with *Trichoderma asperellum* was used. The most increasing the yield and no symptoms of diseases were observed.

IPM of aphids in vegetable field crops in Albania

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Abstract

Different methods are used for control of aphids on field tomato during 2007-2008. Planting time shifting, physical mechanical and agricultural methods are used during the growing season.

The trials consisted in monitoring of aphid species that attack vegetable crops in field and evaluation of effectiveness of some insecticides like thiamethoxam, acetamiprid and azadiractine. Infestation rate leaves were also observed.

The results of monitoring shows that aphids are very active from March to July and have in the Mediterranean climate condition of study area. The first peak of aphid specimens caught in yellow sticky traps was reached at middle of April. After that, there are three more peaks until the end of the season.

Also, the infestation rate of lettuce and tomato leaves shows that at the beginning of sampling were 2% and in one week later reached the economic threshold for treatment. Two foliar applications of Acetamiprid, two weeks apart at the beginning of aphid colonization provided a significant aphid control over Thiamethoxam and Azadiractine.

Key words: tomato, monitoring, yellow sticky traps, thiamethoxam, acetamiprid, azadiractine

Dispersal of click beetles in agricultural fields: a mark recapture study.

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Wireworms remain one of the more pernicious soil pests in field cropping systems. It is apparent that the adult stage – click beetles – are more widespread in agricultural landscapes than the wireworms. Dispersal of adults has become of interest as alternative approaches to insecticides are sought. In this paper we report part of a series of studies to determine what factors may affect click beetle dispersal across fields. Two experimental sites (wheat and fallow) were established with arrays of traps. Batches of marked male *Agriotes lineatus*, and male and female *A. obscurus* were released at the centre of each field. Traps were examined on the day of release and daily thereafter to recover marked beetles giving time periods of 1 to 561 hrs after release. Data for both sites and all release events were analysed as direction or distance travelled from the release point using univariate methods. Only 9.8% of the deviance in directional data could be accounted for, but 22.1% for distance travelled. Female *A. obscurus* travelled significantly less distance than did males but there was no difference between males of the two species. Greater distances were travelled in the wheat than fallow field and the date of release affected both distance and possibly travel direction.

Developing Push-pull Strategies for Pest Control in Brassica Agroecosystems

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Developing push-pull strategies, where several behavioural stimuli are combined and natural enemies proliferate to achieve an optimal pest control, may be a way to lower the damage levels from specialized pest insects in brassica agroecosystems.

The use of Chinese cabbage as a trap crop where insect pathogenic fungi proliferate has been tested in a series of push-pull strategy experiments both in the laboratory and in the field. The pest species studied are the cabbage- and turnip root fly (*Delia radicum* and *D. floralis*). In a dual choice laboratory experiment, both healthy and *Entomophthora muscae* inoculated *D. floralis* were tested for choice of plant for oviposition. The choices were 1) Broccoli against Broccoli 2) Chinese cabbage against Broccoli 3) Broccoli against Broccoli under sown with clover 4) Chinese cabbage against Broccoli undersown with clover. In a semi-field pilot study with Broccoli and Chinese cabbage the choice between main and trap crop for healthy and inoculated flies, as well as fungal transmission between flies over time, was studied. A pilot field study has also been performed in which one aim was to study the distribution of fly cadavers killed by *Entomophthora* sp. in cabbage cultivation with a Chinese cabbage trap crop. The results from the dual choice experiment and both pilot studies will be presented. The results indicate that using Chinese cabbage as a trap crop is a promising strategy for the management of *D. radicum* and *D. floralis*, both as an oviposition attractant and as a trap crop where insect pathogenic fungi may proliferate and kill the adult flies.

In addition, other factors that may influence the effectiveness of a push-pull system are 1) the relative distribution pattern of main- and trap crop within a field, which needs to be adjusted to the behaviour of the target pests, and 2) Interactions between different pest insects as herbivory induces changes of the chemical composition of plants, which may alter the relative attractiveness of the main and trap crop during the season. These factors are currently under study and will be discussed.

Control of leatherjackets in field experiments

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Larvae of the crane flies (*Tipula* spp.), commonly known as leatherjackets, are an important pest in agriculture and horticulture. Problems mainly occur in crop rotations with grass and high maintenance turfs. In a season after pasture or grass for seed production damage may occur in crops like sugar beet, winter cereals and red beet. Overall, leatherjackets prefer moist soil conditions and survival is favored by mild winters.

The two most important species in Western Europe are *Tipula paludosa* and *T. oleracea*. *Tipula paludosa* has one generation a year, eggs are deposited at the end of August till the

beginning of October with larvae L1 and L2 from half September till next spring L3 and L4 June. *T. oleracea* has two generations a year, the first eggs deposition period is in April and May, the second in August and September. The larvae instars are in between the egg deposition period.

The larvae damage seedlings by roots, basic parts of the stem or the lowest leaves during the night period. They may pull the leaves or the complete seedling into their mines in the ground where they consume the whole plant. During daytime the larvae are located close to the plants just beneath the surface of the soil.

Leatherjackets have been controlled for many years with the insecticides parathion – methyl and fenitrothion as a soil treatment. Nowadays, there are no insecticides allowed against leatherjackets in the Netherlands.

In recent years experimental and field trials have been conducted to control leatherjackets in grass, preventing next year problems in several crops.

Few insecticides, biologicals and nematodes were tested applied in autumn. Some products showed the same protection level as the reference compound tested.

Can we use adult craneﬂy counts to monitor larval numbers?

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If we are ever to use biological control agents against leatherjackets then they will need to be targeted against first instars in early October to be effective. At this stage they are not easily recovered from soil and population estimation requires appropriate expertise and resources. An alternative approach might be to use water traps to catch adults to predict leatherjacket numbers. A common sampling design was applied at 25 grass sites in six fields. At each site, a water trap was positioned and emptied at 7 day intervals from 29 August to 24 October 2007. Starting from due north, radii were marked out every 15°, and a set of concentric circles at 5, 10, 20 and 40m distance from the water trap. 5cm diameter soil cores (10 cm deep) were collected at the intersections of the radii from January to March 2008, and leatherjackets extracted. Data were analysed by relating leatherjacket counts to either total or maximum weekly craneﬂy counts. The results indicated that counting the maximum number of females may provide a predictor of leatherjacket populations size, but the significance of the relationship was highly dependent on a single site.

Information and research for vegetable growers in the UK

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For the last 6 years, UK vegetable growers have received information about vegetable pest activity through a web site funded by the Horticultural Development Company (the grower–

funded organisation that funds horticultural research and development in the UK). The service is called the HDC Pest Bulletin and is hosted by the web site at Warwick HRI. The Pest Bulletin provides forecasts for several pests of vegetable crops, summaries of aphid captures by the network of suction traps run by the Rothamsted Insect Survey and other information on pest numbers and activity as it becomes available. It also provides a certain amount of 'historical' data – which can provide useful background information. The Pest Bulletin web pages received more than 32,000 'hits' between April and October 2008. The peak month was June (over 6,000 hits) and the peak day was Monday, 16 June (445 hits). The four most popular pages were, in decreasing order of popularity: the HDC Pest Bulletin home page, carrot fly, turnip moth, cabbage root fly.

The Bulletin starts each year with forecasts, on aphid flights and numbers. The Rothamsted suction traps have been operating since 1964 and the long time series of data from the suction trap network has shown a strong relationship between winter temperature and the time of first appearance of *Myzus persicae*, *Macrosiphum euphorbiae* and *Brevicoryne brassicae* in the traps – all three species are mainly anholocyclic in the UK. There is a similar relationship between winter temperature and the numbers of aphids caught in the traps up until 1st July. These relationships are used to produce the forecasts. Further day-degree forecasts are produced for holcyclic aphids (*Cavariella aegopodii*, *Nasonovia ribisnigri*, *Pemphigus bursarius*). The computer models used to provide the other pest forecasts in the Bulletin are more complex and are part of our decision support software (MORPH). They include forecasts for *Delia radicum*, *Psila rosae*, *Meligethes* spp. and *Agrotis segetum*. Monitoring data includes weekly summaries of the aphids captured in the Rothamsted suction trap network and the numbers of several other pest species in samples taken from experimental plots at Wellesbourne.

I will also provide a brief summary of the work on pests of field vegetable crops over the past two years at Wellesbourne. This includes studies of the biology and behaviour of *Thrips tabaci* on leek and onion, companion planting to control cabbage root fly in cauliflower, insecticidal control of aphids, flies, beetles and Lepidoptera on a range of crops, conservation biocontrol of aphids on lettuce/brassica. New studies include the biology and population dynamics of *Nasonovia ribisnigri* and identification of plant material with resistance to brassica and lettuce pests.