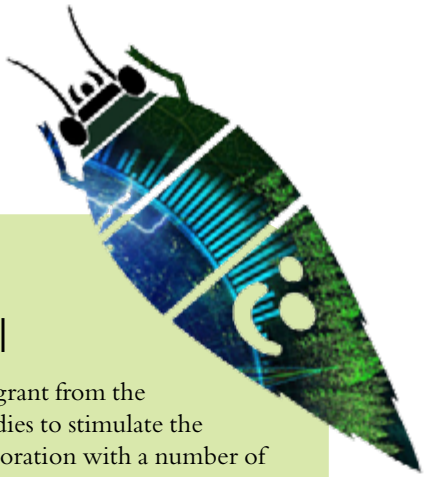
Higlights of 2022

SLU Centre for Biological Control, CBC

A popular science report of CBC's activities



About the SLU Centre for Biological Control

The SLU Centre for Biological Control (CBC for short) is run by SLU with a grant from the Swedish government. Five researchers associated with the Centre engage in studies to stimulate the development and implementation of biological control, working in close collaboration with a number of stakeholders. A specialist communicator is also linked to the Centre.

'Biological control' is a collective term for various strategies to limit pests and pathogens using living organisms; it is an important component of Integrated Pest Management in plant production. Biological control has great potential to restrict the damage caused by harmful organisms, including insect pests and plant pathogens.

Highlights of 2022
- SLU Centre for Biological Control

Year of publication: 2023, Uppsala
Publisher: SLU Centre for Biological Control
Layout: Cajsa Lithell
Illustrations: Fredrik Saarkoppel
Cover Photo: Pxhere

Content

Biological control - more important than ever ---------- 5

Future biological control strategies ---------- 6

Plant health and biocontrol in focus at Älvkarleby ---------- 9

Challenges and possibilities in plant protection ---------- 11

Food security, resilience and herd immunity ---------- 13

CBC in the media ---------- 14

Scientific advice ---------- 15

Master´s projects on biological control ---------- 17

The researchers at CBC ---------- 18

A royal award for biocontrol ---------- 19

Magnus Karlsson – new professor in plant pathology ---------- 20

Team and reference group meetings ---------- 21

Biological control - more important than ever

The SLU Centre for Biological Control, CBC, was established in 2011, at a time when chemical pesticides still dominated most crop protection strategies worldwide. Chemical control still dominates, but since 2011 we have seen a remarkable development in knowledge, methods, market expansion, governing regulations and use of biological control. Importantly, since 2014 a European Union (EU) Directive has obliged all professional plant growers within the Union to apply the general principles of Integrated Pest Management. This Directive spurred many farmers to consider biological control as part of their strategies. A few years later (2020) the European Green Deal was launched, establishing the goal that use of chemical pesticides should be reduced by 50% by 2030. And this year (2022), the European Commission draft proposal for a new regulation on the sustainable use of plant protection products put forward that the 50% reduction should be achieved – to a major extent – by replacing chemical products by biological control. Thus, CBC has never been more relevant than now.

This booklet features some of the many exciting developments at CBC in 2022. Here, you will read about new research on push–pull technology leading to conservation biological control in Rwanda; new vectoring technology featuring flies and bumblebees; conservation biocontrol of weeds; optimization of flower strips; educational efforts; a royal award; and much more. 2022 also marks the final year of Magnus Karlsson at CBC; we will be sad to see him leave, but he now picks up a new professorship and will lead the unit of Agricultural Plant Pathology in Uppsala.

SLU has never had such a strong position in biological control as now. Happy reading!

Johan Stenberg, Director of the SLU Centre for Biological Control

Future biological control strategies

— Examples of research at CBC during 2022

The fungus that attracts male flies to mate with carcasses

A parasitic fungus tricks healthy houseflies into mating with infected, dead female flies of the same species. The fungus is specific to houseflies and may, in the long term, be developed into a biocontrol agent that fights houseflies without harming other species.

– The fungus develops in houseflies and kills them within a few days. Then the fungus grows out of the body of the dead fly to infect new individuals. An infected female carcass gives off an odour that attracts male flies to mate with the carcass. By this means, the male becomes infected and dies. This fungus is not uncommon and can spread like a deadly disease in fly populations, says Paul Becher.

Read more about this research here.

A male fly mating with a dead female fly infected by a fungus. PHOTO: FILIPPO CASTELUCCI

New methods for taming the feared strawberry aphid

The strawberry aphid is a newly arrived pest that can spread harmful viruses to Swedish strawberries. A study at SLU shows that the species is now common in south-western Sweden, but that its spread can be slowed down with the help of resistant plants and natural enemies.

The strawberry aphid is feared as it can spread new and harmful viruses to Swedish strawberry plantations.

– This aphid is common in central Europe, but until recently it was not found in Sweden. But in recent years the strawberry aphid has migrated into Scania and Halland, and it can probably spread further north thanks to climate change, says Johan Stenberg.

– Our results can be used to compose new integrated plant protection concepts that allow us to gain the upper hand against both old and new aphids and the viruses they spread, Johan adds.

Read more about these research results here (in Swedish).

Developing sustainable agriculture systems: Push–pull technology in Rwanda

Food insecurity has been a chronic problem in Africa for many years, and is expected to worsen with continuing population growth, land-use changes and climate change. Small farms, vulnerable to pest attack, produce an estimated

Grace Amboka setting traps and testing the methodology to evaluate soil properties. PHOTO: EIRINI LAMPRINI DAOUTI

90% of African agricultural output, with maize being a major staple and cash crop. One way to develop sustainable and resilient smallholder agricultural systems in East Africa is to use push–pull cropping systems. Researchers from SLU are now investigating how to optimize this technology in Rwanda.

The project is centred around a cropping system called 'push–pull'. This technology reduces pest pressure by providing repellent stimuli (push) combined with attractive stimuli (pull), while also counteracting parasitic weeds from the genus Striga.

– One of the aims here is to protect maize crops from stemborer moths and Fall Armyworm that can destroy the crop, says Grace Amboka (who is now doing her PhD on the subject).

– This ecological intensification technology reduces the conflict between crop production and the conservation of biodiversity and ecosystem services. In addition, it is a sustainable management practice, a cost-efficient and environmentally friendly biocontrol solution to Fall Armyworm, stemborers and Striga weeds, explains Grace.

Read more about this ongoing research project here.

Raspberries: A battleground between flies, yeast and fungi

Fruit flies and yeasts live in close relationships. The larvae of the spotted wing Drosophila, *Drosophila suzukii*, feed on berries and other fruit. A widely distributed yeast called *Hanseniaspora uvarum* is often found in raspberries infested with *D. suzukii* larvae. Can the interaction with yeast be beneficial for both the fly and the yeast?

– Yeasts depend on animals for dispersal and emit volatiles, some of which are pleasant odorants. Animals are attracted to and spread the yeast. We show that *H. uvarum* volatiles attract *D. suzukii* females for egg-laying and larvae for feeding, while suppressing the development of the grey mould *Botrytis cinerea*, says Paul Becher.

Read more about this project here.

Weed seed predation depends on agricultural intensity

Many small rodents and carabid beetles like to eat weed seeds, and we benefit from that in agriculture. But in a new study, field management intensity was found to weaken the ecosystem service of weed seed predation.

– Particular field management practices influence weed seed availability, thus acting as an indirect mechanism limiting the potential for predators to predate weed seeds. We found no evidence that the availability of refugia for seed predators in the surrounding landscape increases seed predation during disturbances in the crop, says Mattias Jonsson.

Weed seed predation can therefore be promoted by reducing disturbances at the field level, regardless of the availability of disturbance refugia in the landscape.

– In the future, we need to explore if supporting a diversity of non-competitive weeds to enhance seed availability can improve the suppression of dominant and competitive weed species, concludes Eirini Daouti.

Read more about this research here.

Longer shelf life and healthier strawberries when bumblebees deliver biocontrol

A biocontrol fungus has been demonstrated to reduce grey mould substantially in strawberry plants when vectored by bumblebees. This led to an improved shelf life of the harvested strawberries by almost 100%. Making new potent biocontrol agents available for further development is important because few sustainable methods currently exist to combat grey mould.

Using bumblebees as vectors of various biocontrol agents is becoming increasingly popular. However, any potentially negative effects on bee performance have yet to be studied in significant detail.

– Our results show that over the four-week period of the trial, the performance and activity of the bees were not negatively affected by the biocontrol fungus *Aureobasidium pullulans*. The bees successfully picked up the powder formulation, then they carried and deposited it on the flowers, says Mudassir Iqbal.

Read more about this research here.

Plant health and biocontrol in focus at Älvkarleby

A course in plant pathology was arranged in May in Älvkarleby for 22 doctoral students from the Nordic countries. The role of microorganisms in biological control of plant diseases was in focus.

– We made a study visit to Nässja plant nursery in Österfärnebo, where we learned more about production and protection of forest plants. It was an intense but educational week with active participants, says Magnus Karlsson, one of the course leaders.

The course was arranged within the NOVA network. NOVA is a cooperative university venture aimed at supporting and enhancing our understanding of major global challenges in a Nordic context.

Read more about the course here.

A study visit to Nässja plant nursery in Österfärnebo was included in the course. PHOTO: DAVID B. COLLINGE

The participants and teachers at the NOVA course held in Älvkarleby. PHOTO: DAVID B. COLLINGE

Panel discussions at the Swedish National Plant Protection Conference at a session on plant protection legislation.
PHOTO: CAJSA LITHELL

Challenges and possibilities in plant protection

— Seminars and conferences

The Swedish National Plant Protection Conference

There is great interest in plant protection issues, not least due to the European Commission's proposal for a regulation whose purpose will be to decrease the use of chemical plant protection products by 50% in the EU by 2030. On November 9–10, the Swedish National Plant Protection Conference was arranged at SLU, where stakeholders gathered to take part in new research, discuss and debate new regulations and collaborate.

Maria Viketoft arranged a session on biological control on the second conference day. Georgina Elena Jiménez from Wageningen University started the session with an introduction on what biological control can offer us today. Researchers Mattias Jonsson and Diana Rubene from SLU talked about their research on weed seed predation and birds in apple orchards.

– We were also lucky to hear about efforts at EU level to improve accessibility of insects and arachnids as biological control agents, and a survey on biological control usage by growers in Sweden from Johanna Jansson of the Swedish Board of Agriculture, says Maria Viketoft.

Read more about the Swedish National Conference for Plant Protection (in Swedish) here.

Plant protection researchers Berit Samils and Hanna Friberg (head of the CBC steering group) study the programme at the Swedish National Plant Protection Conference. PHOTO: CAJSA LITHELL

Controlling toxic pathogens on cereals

On 2 June, Professor Sabrina Sarrocco from the Department of Agriculture, Food and Environment (DAFE) at the University of Pisa in Italy held a seminar at CBC. She talked about beneficial fungi for the control of mycotoxigenic pathogens on cereals. She focused on the case of *Trichoderma gamsii* and Fusarium head blight on wheat.

Biological control in the Swedish Board of Agriculture's webinars

During 2022, Mattias Jonsson and Maria Viketoft gave webinars at the Swedish Board of Agriculture on the subject of weed seed predation and earthworms.

– The concept of inviting both researchers and practitioners to present in joint webinars about a common subject has been very rewarding for everyone, says Maria.

A farmer in a maize field in Nyagatare, in Rwanda's Eastern Province.
PHOTO: 2009CIAT/NEILPALMER (CC BY-SA 2.0)

Food security, resilience and herd immunity

— New research grants at CBC

Increasing maize productivity and quality in Rwanda

Mukesh Dubey has received a 4,5 MSEK grant from the Swedish Research Council (VR). He will investigate the biology and epidemiology of ear rot disease of maize and its association with mycotoxin production. This is crucial for improving maize productivity and quality, and therefore food security in Rwanda. The project is a collaboration between SLU, two universities in Rwanda and the Rwanda Agriculture and Animal Resources Development Board.

Resilience of biological control

Mattias Jonsson co-ordinates a new European project investigating the resilience of biological pest control that has been funded with 920 000 Euro (approximately 2 million SEK to SLU) by Facce JPI Suscrop and Formas. The project will empirically assess how biodiversity contributes to the resilience of conservation biological control in wheat crops across Europe. Mattias and colleagues will study the effects of measures to improve agrobiodiversity and landscape structure on the resilience against agricultural disturbances and climate change. The governance of biological control across Europe will also be analysed. The project is a collaboration between SLU, the University of Giessen, Germany, the University of Verona, Italy, the University of Innsbruck, Austria, and Vilnius University, Lithuania, and will run 2023–2025.

Herd immunity in food crops for increased food safety

Can herd immunity in food crops be achieved through speckled use of resistant cultivars, biocontrol and chemical fungicides? This question will be investigated in a new research project led by Johan A. Stenberg and financed by the Swedish Research Council Formas.

Herd immunity is a form of indirect protection from disease that occurs when a sufficient percentage of a population becomes immune to infection through, for example, vaccination, thereby reducing the likelihood of infection for individuals who lack immunity. If the project is successful, lower amounts of plant protection products can be applied, leading to economic savings and reduced environmental risk.

– In addition, the evolution of counter-resistance will be delayed, thus enabling prolonged durability of plant protection products and resistant cultivars. Cropping security as well as economic and ecological sustainability will improve for farmers, says Johan.

The model system will be strawberry infected by Botrytis cinerea, a fungus that causes grey mould.
PHOTO: JENNY SVENNÅS GILLNER

CBC in the media

— Examples of our research in the media

More pollinators and fewer pests with flower strips

Can flower strips be used to decrease damage caused by insect pests in orchards, fields and greenhouses? Maria Viketoft works on various projects where she investigates how flower strips affect insect life both below and above ground. Now, with the help of prey cards, she will measure the actual benefit of flower strips.

– Does the grower want to benefit pollinators, promote natural enemies or perhaps both? Different plant species have different effects, and it is good to know about them. It is also important to process the ground before sowing and choose a species that grows quickly so that the risk of weeds is reduced. Many choose, for example, lacy Phacelia in the mixture because it grows quickly and attracts insects, says Maria.

Maria has been interviewed about this in several trade journals, for example *Land Lantbruk* and *Viola*. Read more about her work here.

Zombie fungus manipulates flies to mate with carcasses

A parasitic fungus tricks healthy houseflies into mating with infected, dead female flies of the same species.

– The fungus infects almost only the common housefly and no other fly species. In the future, we may use the odor that attracts the houseflies for traps or for a poison that kills houseflies where they need to be fought, says Paul Becher.

See an interview with Paul's co-author Henrik Hjarvard De Fine Licht about this research finding at Expressen.

Lacy Phacelia in flower strips attracts pollinators. PHOTO: ZANCHETTA FABIO (CC BY-SA 2.5)

Scientific advice

CBC continuously communicates about scientific issues with Swedish and international authorities, industry bodies, farmer organizations and individuals.

Winter survival of mites

During 2022, members of CBC have been making risk assessments and producing consultant reports for the Swedish Environmental Protection Agency. In greenhouses and on open-air crops, predatory mites are often used against thrips, dark-winged fungus gnats and mites that damage the crops. But what happens if certain predatory mites, which do not usually live in Sweden, succeed in establishing themselves here?

– We have assessed winter survival for the two predatory mites *Amblyseius degenerans* and *Amblydromalus limonicus*. If they cannot survive Swedish winters, they could be good candidates for biological control of pests as they would not be able to establish permanent populations here, explains Mattias Jonsson.

Use of invertebrate biocontrol agents in the EU

Johan Stenberg has, together with other European researchers, studied the EU's situation and options regarding the introduction, production, evaluation, marketing and use of invertebrate biocontrol agents on behalf of the EU Commission.

– We relied on quantitative data and consulted national authorities from the EU Member States, key representatives from relevant European stakeholders, intergovernmental, scientific and civil society organizations, industry and user associations to make our assessment, notes Johan.

The report is available here.

Winter survival were assessed for the two predatory mites Amblyseius degenerans and Amblydromalus limonicus in a cold chamber. PHOTO: CAJSA LITHELL

Jesper Fritzson in the greenhouse, investigating carrot plants inoculated with fungi and nematodes.
PHOTO: CAJSA LITHELL

Student projects on biological control

— Examples of Master's and Bachelor's project done at CBC

Long-legged flies can be used to fight the European spruce bark beetle

The spruce bark beetle, *Ips typographus*, is a severe insect pest on Norway spruce and reduces timber quality. MSc student Artur Andersson and PhD student Maria Sousa investigated one of the beetle's main natural enemies, namely long-legged *Medetera* spp. flies. The study shows that the fly larvae use specific scents from both the bark beetle as well as beetle-associated microorganisms to find their prey.

Read an interview with Artur Andersson here (in Swedish).

Beetle banks contributes to biological control

The marked agricultural intensification of the last few decades has led to a decline in biodiversity in the agricultural landscape, partially due to the loss of natural habitats. Lisa Carlstrand has investigated how beetle banks and type of crop affect natural enemies and their predation on aphids and weed seeds in her Bachelor's thesis. A beetle bank is a type of semi-natural within-field habitat which can support high densities of predators and reduce the number of aphids within the crop.

– My study shows that crop type affected the abundance of ground-dwelling predators and the predation rate of aphids; more predators were present in winter wheat than flax. In addition, it showed that the predation on aphids and the abundance of spiders decreased with increased distance from the beetle bank, which shows that this beetle bank is an important habitat for spiders and contributes to biological control, says Lisa.

Read an interview with Lisa Carlstrand here (in Swedish).

Lisa Carlstrand by a beetle bank.
PHOTO: MATTIAS JONSSON

Can harmful nematodes be controlled with beneficial fungi?

Jesper Fritzson investigates whether the fungus *Clonostachys rosea* can be used as a biological control agent against root-knot nematodes in his Master's thesis. Nematodes are a group of pests for which biological control is a good control option.

In his experiment, Jesper has inoculated spores from *C. rosea* into soil where he grows lettuce and carrots. In each pot he has also added approximately 5000 nematodes.

– I hope that *C. rosea* will have a negative effect on the nematodes so that they die or do less damage. The idea is that the fungus reduces the reproductive capacity of the nematodes. Perhaps this method can also be used on the nematodes classified as quarantine pests, says Jesper.

Read an interview with Jesper here.
Read Jesper's Master's thesis here.

The researchers at CBC

— Our operational group

This is the operational group that has been active during 2022. The people in our operational groups are team leaders and work with post docs, PhD students and Master's students. Magnus Karlsson has become a professor in agricultural plant pathology and will leave CBC in 2023 to focus on this new adventure in his career.

Paul Becher - studies chemically mediated interactions between organisms, including host-finding and sexual communication in insects. He is specifically interested in the function of semiochemicals in biological control.

Mattias Jonsson - specializes in insects and arachnids for biocontrol. He mainly focuses on natural and conservation biological control of invertebrate pests in agroecosystems.

Magnus Karlsson (Deputy director) - is interested in micro-organisms and their interactions with other microbes, plants and the environment. He investigates fungal interactions in relation to plant pathology and biological disease control.

Cajsa Lithell - CBC's Communications Manager.

Johan Stenberg (Director) – Johan's work focuses on optimization and evolution-proofing biocontrol within the framework of Integrated Pest Management, often involving wild genetic resources and studies of natural selection in agroecosystems.

Maria Viketoft – works on nematode ecology, particularly these worms' interactions with plants (crops and wild species) and other soil organisms.

A royal award for biocontrol

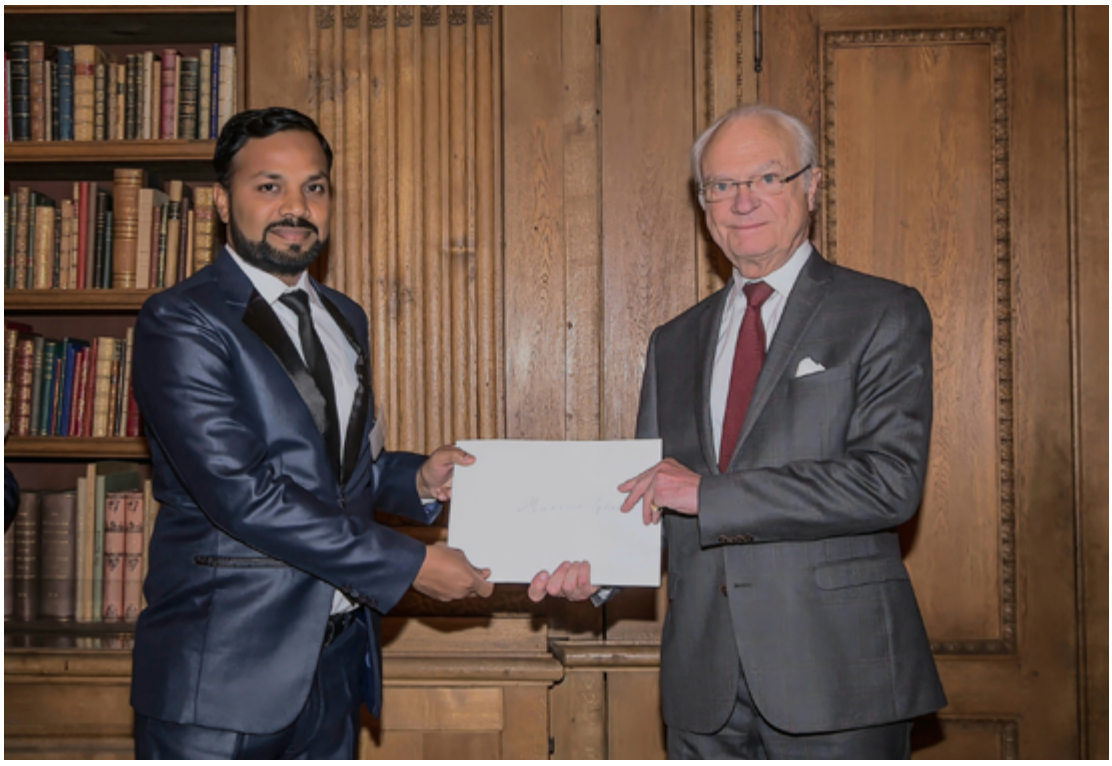
– Mudassir Iqbal received an award from King Carl XVI Gustaf

Mudassir Iqbal received an award for research on biological pesticides from the King Carl XVI Gustaf 50th Anniversary Fund for Science, Technology and Environment. The scholarship was awarded on 25 May in the Royal Palace.

– I will use the prize money to study the evolutionary factors that enable beneficial organisms to develop the ability to effectively fight disease-causing organisms, says Mudassir.

– Mudassir came to Sweden from Pakistan in 2015 and has since made a remarkably inspiring research journey. The project Mudassir works with is innovative and has great potential to, in the long run, provide Swedish farmers with biological pesticides that are significantly more effective than the biological agents we have today, says Professor Johan A. Stenberg who leads the group at the Department of Plant Protection Biology in Alnarp, where Mudassir is now working on his postdoctoral project.

Read more about Mudassir's award here.



Mudassir Iqbal receives a prestigious award for research on biological pesticides from His Majesty King Carl XVI Gustaf in May 2022. PHOTO: CLAS GÖRAN CARLSSON

Magnus Karlsson – new professor in plant pathology

Magnus Karlsson develops effective strategies to protect our crops against diseases with sustainable methods that do not have a negative impact on the environment. Since 1 September he has been a new professor in plant pathology in agriculture at SLU.

On the one hand, Magnus works with biological control of diseases, where he tries to replace chemical plant protection products with micro-organisms that co-operate with the plant and can prevent the onset of diseases. He also works with plant breeding, where the goal is to develop crops that are resilient and resistant to diseases. In both cases, a deeper understanding of the biology of the micro-organisms that cause the disease is central to success.

– I want to connect my two current lines of research by exploring the possibilities of breeding plants to be able to better co-operate with micro-organisms that can provide increased resistance to disease and climate stress. In that context, I also see great opportunities to work in parallel with breeding the plant and with breeding the micro-organisms to generate combinations that provide added value for the farmer, says Magnus.

Read an interview with Magnus here (in Swedish).

Magnus Karlsson doing field trials with quinoa in Bolivia. PHOTO: MUKESH DUBEY

Team and reference group meetings

This year the reference group meeting and the CBC team meeting were held in connection with the Swedish National Plant Protection Conference at Uppsala.

A bridge between academia and society

The tasks of the SLU Centre for Biological Control include dissemination of the University's collective knowledge for the benefit of society and the provision of a bridge between academia and various external actors, as well as between researchers. CBC's reference group provides one such bridge for interacting with other actors in society. The aim is to develop knowledge and understanding of biocontrol through collaboration between SLU and these actors.

On 8 November the annual meeting with the reference group was held at campus Ultuna. The reference group consists of representatives of the Swedish Board of Agriculture, Swedish Environmental Protection Agency, Swedish Chemicals Agency, Swedish Federation of Rural Economy and Agricultural Societies, LRF

Mattias Jonsson presents his ongoing research in front of the reference group. PHOTO: CAJSA LITHELL

(Federation of Swedish Farmers), RISE (Research Institutes of Sweden) and Bayer.

– At this meeting we were happy to welcome our new reference group member, Lisa Rydenheim from Bayer, says Johan Stenberg.

Team meeting in Uppsala

On 11 November, CBC held its annual team meeting, with researchers from campus Ultuna and campus Alnarp participating. During the day, the team members gave each other updates on ongoing research and talked about future collaborative projects and interesting and important ways to take biological control research further.

The participants at the CBC team meeting in Uppsala. PHOTO: CAJSA LITHELL

SLU

SCIENCE AND EDUCATION **FOR SUSTAINABLE LIFE**

SLU, Sveriges lantbruksuniversitet, har verksamhet över hela Sverige. Huvudorter är Alnarp, Uppsala och Umeå.
SLU är miljöcertifierat enligt ISO 14001 • Telefon: 018-67 10 00 • Org nr: 202100-2817