471
Julius-Kühn-Archiv

14th Young Scientists Meeting Conference 2022

9th – 11th November
in Berlin

- Abstracts -

learning | together | with each other | from one another

YSM
Young Scientists Meeting

Julius Kühn-Institut
Bundesforschungsinstitut für Kulturpflanzen

Kontaktadresse/ Contact
Dr. Anja Hühnlein
Julius Kühn-Institut (JKI)
Bundesforschungsinstitut für Kulturpflanzen
Informationszentrum und Bibliothek
Erwin-Baur-Straße 27
06484 Quedlinburg
Germany

E-Mail: ib@julius-kuehn.de
Telefon: +49 (0) 3946 47- 2206
Telefax: +49 (0) 3946 47-255

Wir unterstützen den offenen Zugang zu wissenschaftlichem Wissen.
Das Julius-Kühn-Archiv erscheint daher als Open-Access-Zeitschrift.

Das Julius-Kühn-Archiv ist online verfügbar unter
https://www.openagrar.de/receive/zimport_mods_00001710?q=julius-k%C3%BChn-archiv

The Julius-Kühn-Archiv is available free of charge at
https://www.openagrar.de/receive/zimport_mods_00001710?q=julius-k%C3%BChn-archiv

Herausgeber / Editor
Julius Kühn-Institut, Bundesforschungsinstitut für Kulturpflanzen, Quedlinburg, Deutschland
Julius Kühn Institute, Federal Research Centre for Cultivated Plants, Quedlinburg, Germany

DOI **10.5073/20221018-082639**
ISSN **2199-921X**
ISBN **978-3-95547-122-4**

© Der Autor/ Die Autorin 2022.
Dieses Werk wird unter den Bedingungen der Creative Commons Namensnennung 4.0 International Lizenz (CC BY 4.0) zur Verfügung gestellt
(https://creativecommons.org/licenses/by/4.0/deed.de).

© The Author(s) 2022.
This work is distributed under the terms of the Creative Commons Attribution 4.0 International License
(https://creativecommons.org/licenses/by/4.0/deed.en)

Greetings from the President

It is a great pleasure for me that the Young Scientists Meeting (YSM) can finally take place as a face to face meeting, again. For the majority of the participants of last year's online meeting, it is particularly important that the YSM 2022 again offers personal encounters, individual discussions and, above all, opportunities for mutual exchange among each other. With the 14th YSM, all of this will be possible, again.

In twentyseven talks and just as many posters, you can introduce your research and demonstrate the results obtained so far to your colleagues. The YSM is the only event at the JKI that provides this unique broad insight into the diverse research areas.

In addition, the YSM program offers two keynotes: "Multifunctional, regenerative land use - facilitating the complexity of nature for resilient and climate positive forms of agriculture and forestry" by Max Küsters (Gut&Bösel) and "Mendel's legacy in modern plant breeding" by Dr. Elke Diederichsen (FU Berlin) – an actual topic on the occasion of this year's 200th birthday of Gregor Mendel.

I am particularly pleased that the topic "Career pathways & Networking", in which former Young Scientists of the JKI will explain their diverse career paths after finishing PhD and will give advice on how to organize your time at the JKI efficiently and build networks, is part of the programme.

I would like to thank Dr. Andrea Krähmer and the whole team of the Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection (ÖPV) for hosting and supporting the YSM 2022. On a walking tour through the institute, you will learn about the research activities of ÖPV.

For the first time in the fourteen-year history of the YSM, two field trips will be offered at the end of the meeting. Check out the "urban green spaces" in Berlin or the exciting CUBES Circle Project of the Humboldt-University of Berlin (with participation of the JKI) dealing with urban agricultural production.

I wish all of you a successful and pleasant meeting both scientifically and socially as well as interesting and inspirational discussions.

Berlin, November 2022

Prof. Dr. Frank Ordon

President of the JKI

Table of contents

Session C

Session D

Session E

Poster

Talks

Session A

Validation of candidate genes as molecular markers for the apple replant disease

Baader, Luisa; Flachowsky, Henryk; Schröpfer, Susan; Reim, Stefanie

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Fruit Crops, Dresden, Germany.
Email of corresponding author: luisa.baader@julius-kuehn.de

Apple (*Malus × domestica* Borkh.) is the most important fruit produced in Germany, but apple orchards and tree nurseries increasingly face the problem of apple replant disease (ARD). ARD is a soil-borne disease that arises through replanting and leads to severe growth depression as well a decline in fruit quality and yield. Despite the economic relevance of this disease, its causes are poorly understood and so far no sustainable countermeasures are available.

The ORDIAmur project is a BMBF funded joint project for overcoming the apple replant disease by an integrated approach. Its aim is to investigate the causes of ARD and to develop sustainable, environmentally friendly and economically feasible measures against it. In previous studies of the project, it was shown that ARD is associated with deleterious shifts in soil biota community composition, and it is suspected that root exudates and decomposition products of dead apple plant material induce these changes of the soil biome. At the Institute for Breeding Research on Fruit Crops in Dresden-Pillnitz the focus of the project is on investigating the interactions between the plants and the soil and elucidating the genetic mechanisms that underlie tolerance to ARD.

Apple plants react with very high levels of stress defense to ARD, including the synthesis of phytoalexins, which are known to act in an induced defense mechanism against biotic stressors. This reaction varies in quality and quantity between different soils and genotypes.

Transcriptomic studies of apple plants grown in ARD soil revealed the induction of genes associated with the biotic stress response. Several genes, whose expression correlates closely with the phenotypic reactions of apple plants to ARD, as for example the biphenyl synthesis genes, have been identified.

The aim of this project is to identify further candidate genes that can be used as molecular markers for the reaction of apple plants to ARD. For this, 90 candidate genes were selected that have previously been shown to be differentially expressed in the susceptible rootstocks ‘M9’ and ‘M26’ as well as the ARD-tolerant wild apple accession *Malus × robusta* 5 under ARD conditions. These candidate genes will be validated by analyzing their expression by RT-qPCR with apple plants grown on 150 different sites in Germany.

Additionally, the effect of several ARD countermeasures on the expression of the candidate genes will be investigated in different apple genotypes. The experimental procedure of the candidate gene expression analysis will be optimized in order to develop a fast and cost-efficient molecular marker based method to measure the severity of ARD in soils.

Effects of organic fertiliser and autumn fertiliser application on Nitrogen use efficiency on arable farms

Zieseniß, Steffen; Dieser, Mona; Mielenz, Henrike; Müller, Karolin; Greef, Jörg-Michael; Stever-Schoo, Burkhard

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
Email of corresponding author: steffen.zieseniss@julius-kuehn.de

Intensive use of nitrogen fertilizer in some regions of Germany led to nitrogen pollution of the ground water and therefore to negative environmental effects. In 2016, European Court of Justice condemned the Federal Republic of Germany for violating the European Nitrates Directive (91/676/EEC). In the course of this, a demonstration project with a set of early indicators was developed to monitor nitrate loads from agricultural land. The monitoring approach combines analytical and calculatory indicators and aims at determining the effects of political measures on agricultural nitrate loads. Here, we focus on calculatory indicators i.e. nitrogen balances at field scale in five regions in Germany. These balances describe the total nitrogen loss potential. To further evaluate this potential, on-farm data from 48 farms is analysed with the concept of nitrogen use efficiency (NUE) to compare arable farms at field scale. Nitrogen output was used as indication for yield and a target value of 80 kg N ha^{-1} a^{-1} was set as a desirable minimum output to ensure productivity. In order to account for unavoidable losses, the target value for the nitrogen surplus was set to 50 kg N ha^{-1} a^{-1} and for the efficiency between 70 and 90 % NUE. The results show decreasing NUE with increasing amounts of organic fertilizer application. Likewise, excessive nitrogen fertilization in autumn reduces nitrogen use efficiency and thus increases nitrogen loss potential. This approach offers the possibility to identify potentials for the optimization of nitrogen use and thus to reduce nitrogen loads from arable farm land to ground and surface water.

This work was financially supported by the German Federal Ministry of Food and Agriculture (BMEL) through the Federal Office for Agriculture and Food (BLE), grant number 2820ABS001.

Effect of irrigation and sowing pattern on the growth and yield of spring barley

Meziane, Asmae[1]; Rawat, Akansha[1]; Osadolor, Scott[1]; Töpfer, Veronic[2]; Matros, Andrea[2]; Wehner, Gwendolin[2]; Bleser, Susanne[3]; Linkies, Ada[3]; Schmitt, Annegret[3]; Feike, Til[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
[3]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Biological Control, Dossenheim, Germany.
Email of corresponding author: asmae.meziane@julius-kuehn.de

Climatic change shows a spiraling trend of scarce rainfall mirrored with a fall of majorly produced cereals such as barley. Thus, finding solutions through crop management and cultivar selection has become crucial to minimize crop losses and stabilize the dropping trends.

In this study, we test the effects of irriga-tion and sowing patterns on five geno-types. We conducted the experiment in 2021 at the experimental fields of Julius Kuehn Institute in Berlin. We applied three irrigation treatments: Rainfed, supplementary irrigation (irrigation is applied when plant available water capacity (PAWC) < 30% and refilled to 70%), and non-limiting irrigation (irrigation is applied when PAWC < 50% and refilled to 100%). We tested four genotypes, which are promising to feature high drought stress tolerance, i.e., Morex, Golden Promise, BCC1589, HOR7985, and we used RGT Planet as a reference. We further tested two sowing patterns with a sowing density of 290 seeds/m², i.e., equidistant sowing in a triangular pattern with 6 cm distance between single plants vs. conventional row drilling at 11 cm row distance. The main traits we assessed during the growing season are plant spacing, above-ground biomass, and weekly, we assessed crop phenology, canopy height, leaf area index (LAI), as well as multi-spectral indices such as normal-ized differential vegetation index (NDVI), soil adjusted vegetative index (SAVI), crop water stress index (CWSI), etc. using the MicaSense-Altum camera, mounted on a copter. At harvest, we assessed yield and yield components.

The uniform sowing pattern showed substantially stronger canopy coverage and significantly higher NDVI than conventional drill seeding for all five genotypes in early vegetative stages (39 days after sowing (DAS)). Later in the season, i.e., from 61 DAS to 91 DAS, we experienced a drought period that coincided with the flowering and beginning of the grain filling stage, resulting in a significant difference between irrigated and rainfed treatments. We observed the highest values of LAI under the irrigated treatments for the genotypes Golden Promise, BCC1589, and RGT planet. Under all irrigated treatments, we recorded a significantly higher grain yield for all genotypes, except for Morex. We observe a significant effect of sowing pattern on yield of the reference cultivar RGT Planet under rainfed and supplementary irrigation. The genotype Morex expresses drought tolerance traits, as it does not underperform under water stress; however, it generates significantly lower yields compared to the reference cultivar. Although we aim to identify drought tolerance traits, it is important that these traits do not relate negatively with yield and quality traits.

Identification of the *Biscogniauxia* teleomorph of *Cryptostroma corticale* for the development of sustainable strategies to protect sycamore from sooty bark disease

Brenken, Ann-Christin; Enderle, Rasmus; Riebesehl, Janett

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Urban Green, Braunschweig, Germany.
Email of corresponding author: ann-christin.brenken@julius-kuehn.de

Cryptostroma corticale (Ellis & Everh.) P.H. Greg. & S. Waller, the causal agent of sooty bark disease, has led to the death of sycamore (*Acer pseudoplatanus* L.) in many regions in Germany and other European countries in the recent years, especially supported by dry and hot summers. As a result, there is an urgent need for further scientific research on this pathogen in order to develop sustainable strategies for the protection of sycamore.

The fungus belongs to the ascomycetes and is classified in the genus *Biscogniauxia* Kuntze due to its genetic similarities. Unlike the other *Biscogniauxia* species, *C. corticale* is not known to have a teleomorphic fruiting body, despite a relatively diverse population structure has been demonstrated by somatic compatibility experiments. For these reasons, it is unlikely that *C. corticale* does not form a teleomorphic fruiting body. More likely, it can be assumed that it exists a teleomorphic fruiting body of *C. corticale*, but it has not yet been recognized as such. Therefore, it is possible that the teleomorph, for which it is searched, is not yet described or it could be found in the already described but not yet sequenced species of the genus *Biscogniauxia*.

In the current project, as many different cultures (mainly from material collected in Germany) and fungarium specimens (from around the world) as possible from the genus *Biscogniauxia* will be collected and gathered. Subsequently they will be evaluated and analyzed morphologically and phylogenetically with different marker genes.

First phylogenetic results with the marker gene region ITS confirm the partly high genetic similarity of *C. corticale* to the genus *Biscogniauxia*. However, a teleomorphic *Biscogniauxia* species that can be genetically assigned with certainty to the anamorphic species *C. corticale* has not yet been found. Furthermore, it appears that the previous taxonomic classification of some *Biscogniauxia* species is not conclusive in itself.

The further acquisition of marker sequences is necessary to further search for the teleomorphic fruiting body of *C. corticale*, as well as to perform a comprehensive phylogenetic analysis and to contribute to fungal DNA-barcoding.

Phytosanitary effects of aqueous extracts from essential oil production

Kümmritz, Sibylle[1]; Austel, Nadine[1]; Jensch, Christoph[2]; Meiners, Torsten[1]; Strube, Jochen[2]; Krähmer, Andrea[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection, Berlin, Germany.
[2]Clausthal University of Technology, Institute for Separation and Process Technology, Clausthal-Zellerfeld, Germany.
Email of corresponding author: sibylle.kuemmritz@julius-kuehn.de

Essential oils (EOs) from medicinal and aromatic plants (MAPs) are characterized by a broad spectrum of biological activities, especially against plant pathogens and insect pests. Compared to many synthetic pesticides, their advantages lie in their volatility and the associated low persistence as well as the absence of problems due to resistance development. Therefore, there is little concern with field application, especially just prior to harvest, which is likely for many synthetic products due to critical residues.

The commercial use of EOs and their by-products is mainly limited to human applications and veterinary medicine, resulting in limited application in crop protection. During steam distillation, the distilled biomass (residual pomace) and an aqueous condensed phase, so-called hydrolate, are by-products in addition to the essential oil. They still contain residual amounts of essential oil components and could be used as sustainable and eco-friendly alternative in plant protection.

Our studies focus on hydrolates and pressurized hot water extracts (PHWE) of MAPs relevant for cultivation and distillation in Germany. In vitro tests with hydrolates showed antifungal effects against the phytopathogenic fungi *Botrytis cinerea*, *Fusarium culmorum* and *F. sambucinum*. Furthermore, selected hydrolates were sprayed on *Brassica napus* plants under field conditions. In a randomised block design, the bioactivity of hydrolates against the herbivorous pollen beetle *Brassicogethes aeneus* was assessed by flower bud damage. Laboratory studies of olfactory orientation of beetles to tested hydrolates and PHWE confirmed the repellent effect on beetles as observed in the semi-field trial (2020-2022). Gas chromatographic methods uncovered potentially active substances of bioactive hydrolates and PHWE. In addition, we observed only minimal effects of selected hydrolates on non-target organisms such as earth worms and nitrogen mineralization and nitrification in soils.

This will increase the value added for residual and waste streams from the extraction of essential oils in the field of biobased plant protection. With the utilization of these by-products and the development of new applications, MAPs cultivation is to be expanded not only in Germany.

This cooperation project is funded by the Federal Ministry of Food and Agriculture (BMEL) based on a resolution of the German Bundestag and coordinated by the Agency for Renewable Resources (funding code: 22021517) under the program "Renewable Resources".

Session B

Reproduction potential and Host range of *Meloidogyne enterolobii* and *Meloidogyne incognita*

Koniganahalli Gopal, Hemanth K.[1]; Danchin, Etienne G.J.[2]; Kiewnick, Sebastian[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Braunschweig, Germany.
[2]INRAE, French National Institute for Agriculture, Food and Environment, France.
Email of corresponding author: hemanth.gopal@julius-kuehn.de

Meloidogyne enterolobii, is one of the economically important root-knot species as its ability to develop and reproduce on host plants carrying resistance to other major root-knot nematodes. Recent reports around the world on wide range of plants species including major crops depicts its wide spread. Due to polyphagous nature of *M enterolobii* and limited control measures, it is important to understand host range to reduce further spread and develop control measures.

Meloidogyne incognita and other tropical RKN species are controlled using resistant cultivars carrying Mi gene, but recent reports have shown that virulent isolates of *M. incognita* are capable to overcome resistance. To determine the host range of 8 *M. enterolobii* populations and 2 virulent isolates of *M. incognita*, a study was conducted within the framework of ANR (FR)/DFG (DE) project AEGONE (431627824).

20 crops species previously classified as non-, minor- or major-hosts to *M. enterolobii* were challenged under greenhouse conditions with 8 *M. enterolobii* populations (collected from different geographic areas and hosts) and 2 virulent isolates of *M. incognita* reared as single egg mass lines. Based on the determined reproduction factor (RF), crops were categorized as good-host (RF is ≥1), poor-host (RF between 0 and 1) or non-host (RF=0). Among 20 plant species, 10 showed RF values ≥ 1 for all 8 *M. enterolobii* populations and 12 showed RF values ≥ 1 for both virulent isolates of *M. incognita*. Although several reports suggested roses as minor-host to *M. enterolobii*, no reproduction was observed in all *M. enterolobii* populations and as well in *M. incognita* isolates tested. Contrary to recent reports, phacelia and fodder radish were good hosts for 5 and 7 populations of *M. enterolobii,* respectively.

Based on the results it was demonstrated that several populations of *M. enterolobii* and virulent isolates of M. incognita are capable of reproducing on crops previously reported as non-hosts. Therefore, further studies are underway to investigate the potential to adapt to initially poor hosts, the related costs of fitness and to determine variations on the genome level with differences in host compatibilities.

Distribution and damage potential of plant parasitic nematodes on medicinal and aromatic plants in Germany

Noskov, Ilya[1]; Blum, Hanna[2]; Komnik, Hansjörg [2]; Hallmann, Johannes[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Epidemiology and Pathogen Diagnostics, Braunschweig, Germany.
[2]Institut für Nutzpflanzenwissenschaften und Ressourcenschutz (INRES), Rheinische Friedrich-Wilhelms-Universität Bonn, Rheinbach, Germany.
Email of corresponding author: ilya.noskov@julius-kuehn.de

Yield reductions on medicinal and aromatic plants occur repeatedly in practice. Plant parasitic nematodes are often assumed to be the cause but the concrete data is scarce. As part of the joint project NemaAG, funded by the Federal Ministry of Food and Agriculture and in collaboration with partners from research, consulting and producers, we are investigating the distribution and da-mage potential of plant parasitic nematodes on medicinal and aromatic plants. The damage potential and host status of economically important nematode species is also being studied on some selected plants such as peppermint, parsley, marjoram and valerian.

After a detailed evaluation of more than 300 soil samples, collected in 2021, it can be noted that plant parasitic nematodes show widespread occurrence on medicinal and aromatic plants in both conventional and organic field practices. *Pratylenchus* and *Tylenchorhynchus* have been recorded in more than 80% of all examined fields, followed by *Helicotylenchus*, *Paratylenchus* and *Trichodorus / Paratrichodorus* with 30 - 50% accor- dingly. The genera *Meloidogyne* and *He- terodera*, which are usually present in high numbers on agricultural crops, have been rarely found (< 10 %). The densities of frequently occurred genera have shown the strong fluctuations depending on cultivated plant and field location, e.g. *Pratylenchus*: 93 - 800 nematodes / 100 ml soil, *Tylenchorhynchus*: 70-3344 nematodes/100 ml soil, *Paratylenchus*: 133-1736 nematodes/100 ml soil, *Meloidogyne*: 33-244 nematodes/100 ml soil.

Host status and damage potential of economically important *Meloidogyne* species have been studied on peppermint. The experiments confirmed that peppermint is non host plant for *M. fallax* and *M. chitwoodi*; host plant for *M. incognita* and *M. hapla*, however the reproduction rates are clearly lower than by tomatoes, especially for *M. incognita*. Studies on parsley and valerian have been conducted with *M. hapla* and confirmed that both are hosts for *this species.* Furthermore, the all described above conducted greenhouse experiments showed that nematode densities up to 2 500 *Meloidogyne* species / plant have no negative impact on plant growth. Also no symptoms were observed on aboveground plant material, which are typical for a nematode damage.

Characterization of the JKI strawberry cultivar collection in scope of the EU research project BreedingValue

Pinczinger, Dora; Höfer, Monika; Flachowsky, Henryk

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Fruit Crops, Dresden, Germany.

Email of corresponding author: dora.pinczinger@julius-kuehn.de

Strawberry, *Fragaria ×ananassa* Duch., has the largest economic importance of the small fruit crops grown in the temperate regions of the world. Strawberry is an octoploid species, originated from an interspecific hybrid crossing of *F. chiloensis* and *F. virginiana* in the 18th century in Europe. Since then, strawberry breeding has seen a large impact from European breeders. However, strawberry breeding has been largely privatized in the recent past, which hindered the exchange of new knowledge. Furthermore, changes in climate, cultivation techniques, consumer needs and disease distribution demand a new approach from breeding. The EU-funded project "BreedingValue" brings breeders, researchers and producer associations together and aims to address these new challenges by using genetic resources from the collections of the project partners.

The Julius Kühn Institute (JKI) is one of the 20 public and private institutions participating in the project. The Institute for Breeding Research on Fruit Crops in Dresden-Pillnitz has a strawberry gene bank of 187 cultivars and 284 accessions of *Fragaria* wild species as part of the German Fruit Genebank (DGO). The Institute offers not only genetic resources, but also their knowledge about traditional cultivars and experience with characterizing and evaluating traits in the crop.

One of the most important roles of a gene bank is to maintain a collection of true-to-type cultivars. Cultivar identification can be done in two ways: by genotyping and by pomological assessment. With genotyping, marker data is used in combination with pedigree information to verify cultivars by their known relationships. Pomological assessment is done by identifying morphological traits typical for a cultivar. There are several traits used for this purpose, for instance fruit form, achene depth, leaf color, or leaf gloss. However, these are not the only traits evaluated in Dresden-Pillnitz. The cultivar collection is phenotyped for breeding relevant traits like fruit firmness, acid, sugar and vitamin C content as well.

Through this genotyping and phenotyping data, interesting traits can be identified in the cultivar collection of the JKI. Cultivars with these traits can be then used by breeders in the future development of resilient and added value strawberry cultivars.

May I introduce? The city of the Grey-Backed Mining-Bee *Andrena vaga* and her flat mates

Gardein, Hanna[1]; Diekötter, Tim[2]; Greil, Henri[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Bee Protection, Braunschweig, Germany.
[2]Christian-Albrechts-University, Department of Landscape Ecology, Kiel, Germany.
Email of corresponding author: hanna.gardein@julius-kuehn.de

Ground-nesting bees constitute the vast majority of all wild bee species. Although they are the most abundant functional group of wild bees, ground-nesting bees are less studied than cavity nesting bees. The importance of floral resource availability on bees has been studied extensively, whereas findings about their nesting requirements are lacking. Especially precise measurements and detailed descriptions about the nesting site characteristics specific ground-nesting bees depend on are needed. Information about nesting site preferences and tolerable ranges is crucial for wild bee conservation.

In our study, the Grey-Backed Mining-Bee *Andrena vaga* is used as a model species to draw conclusion how the ideal nest site location for this and other ground-nesting bee species might be characterised. In the study area, *Andrena vaga* is quite common. Further, it is easily identifiable and forms large nest aggregations, which allows locating as many nesting sites as possible with the help of Citizen Science.

Around 60 nest aggregations within the city of Braunschweig were found of which 27 were selected for detailed analyses. For this purpose, soil samples were taken and are currently analysed regarding texture, water content, pH, organic material, salinity and the presence of heavy metals. Additionally, both the soil and the surface temperature as well as the solar irradiation were monitored. Site characteristics like the soil density, slope, exposition and vegetation cover were surveyed. All parameters will be compared with the conditions on an un-colonised control. With the help of this data, ideal nesting sites, especially within cities, can be protected or created. Further, this knowledge helps to conduct studies of nesting individuals within a laboratory.

Additionally, the health status of the bees should be analysed and compared between the different aggregations. Hence, emergence traps were used to sample recently emerged individuals and relate them to the nesting sites. With the help of the traps, it can be controlled that collected bees have not immigrated from other nest sites. The parasitism rate and the sex ratio were calculated. Furthermore, the body size of the sampled animals will be measured by their intertegular distance. The variables will then be analysed for correlations with landscape characteristics, aggregation size and the nesting site parameters. With the help of this data, it is possible to draw conclusion, which factor determines the development and chances for reproduction of the bees.

The study is part of the BeesUp Project, which is funded by the Federal Program on Biological Diversity through the Federal Agency for Nature Conservation (BfN) with funds from the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV).

Detection of virulent potato cyst nematodes using hyperspectral signatures

Kölpin, Frederik[1]; Daub, Matthias[1]; Lakämper, Niels[2]; Gerighausen, Heike[2]; Schmidt, Kai[3]; Rostás, Michael[4]; Mahlein, Anne-Katrin[5]; Kiewnick, Sebastian[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Braunschweig, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
[3]Nemaplot, Dr. Kai Schmidt, Bonn, Germany.
[4]University of Göttingen, Agricultural Entomology , Göttingen, Germany.
[5]Institute of Sugar Beet Research, Göttingen, Germany.
Email of corresponding author: frederik.koelpin@julius-kuehn.de

The emergence of the new virulence type "Emsland" of the quarantine potato cyst nematode *Globodera pallida* (*G. pallida*) has led to a new thread for potato production.

Since there are neither resistant potato cultivars against the new virulence type nor nematicides available, a sufficient monitoring is crucial. Once a field is contaminated with *G. pallida*, the nematode is able to endure 20 years or longer in the field, which blocks future cultivation of potatoes or other Solanaceae in the crop rotation.

The new virulent population was able to spread undetected, due to cost- and labor-intensive conventional monitoring systems. The typical occurrence in nests of cyst nematodes reduces the probability of localizing an infestation, in addition to the high effort for soil sampling and extraction for detection and identification. If an infestation is recognizable, for example by wilting symptoms, stunted growth or a positive result after taking a soil sample, an area is already significantly contaminated.

The objective of the research project is to develop a detection system based on hyperspectral sensor information. The target value is the detection of early / latent infestations. An early / latent infestation already leads to a strong increase in population densities of *G. pallida*, without visible symptoms. In addition, the level of virulence present should be estimated.

The detection system will be based on an imaging hyperspectral camera (400 – 1000 nm) and on a leafclip attachment, at different inoculum levels of *G. pallida.* Additionally, developmental stages are investigated by destructive sampling in combination with determination of water, chlorophyll and nitrogen content of the plants.

The collected data should be incorporated into a self-learning algorithm, to support early detection of a latent *G. pallida* infestation of virulent populations.

The project aims to develop detection methods for virulent *G. pallida* populations and provides the groundwork for monitoring systems, e.g. using drones or remote sensing. The results serve as a basis for the plant protection services to protect production areas from long-term contamination and thus to avoid a long-term blocking of potato cultivation.

Session C

Biodiversity of arthropods in viticulture – Influence of management and landscape

Kaczmarek, Marvin[1,2]; Entling, Martin H.[2], Hoffmann, Christoph[1]

[1]Julius Kühn Institut (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Fruit Crops and Viticulture, Siebeldingen, Germany.
[2]Institute for Environmental Sciences, iES Landau, University of Koblenz-Landau, Landau in der Pfalz, Germany.
Email of corresponding author: marvin.kaczmarek@julius-kuehn.de

Arthropod biodiversity has strongly declined in many agricultural landscapes in the past decades, which is, among other reasons, attributed to intensified agriculture. However, it is not known whether such negative trends are also occurring in viticulture, where the conditions for species may have recently improved in the context of integrated plant protection with no further use of insecticides and the establishment of greening in the inter-rows of vineyards. The occurrence of species in viticulture can be influenced both by management practices within the vineyard and by the landscape in the surrounding area. Besides the use of either conventional or organic pesticides, the frequency of spraying can have an impact on arthropods. The cultivation of fungus-resistant grapevine varieties (FRG), for example, requires fewer applications of pesticides compared to classical varieties and can thus be beneficial for biodiversity. Greening of inter-rows as well as semi-natural habitat structures in the surrounding area can also promote biodiversity by providing feeding and nesting resources for various species.

In this project, we are investigating how local management, the cultivation of FRG varieties, and the surrounding landscape affect the biodiversity of arthropods in vineyards. Using e.g. Malaise traps, we assess biodiversity in eight landscapes in the wine-growing region Palatinate in southwest Germany, which form a gradient in the proportion of semi-natural habitats within a radius of 1,000 meters of the vineyards. In each landscape, we sampled two conventionally and two organically managed plots, planted with either a classical or a FRG variety. Species are determined using morphological and molecular methods (metabarcoding). The results will provide information on the importance of local management and landscape structure for the occurrence of species and form as part of the “National Monitoring of Biodiversity in Agricultural Landscapes” (MonViA) the basis for a long-term monitoring of arthropods in viticulture.

How do different crop type classifications affect biodiversity metrics in arable regions in Germany: towards (geo)data fitness for use quality metrics

Uhlott, Jannes; Möller, Markus; Gerighausen, Heike

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute of Crop and Soil Science, Research Center for Remote Sensing in Agriculture, Braunschweig, Germany.
Email of corresponding author: jannes.uhlott@julius-kuehn.de

The increasing intensification of agricultural production due to rising population numbers and changing dietary habits is leading to a sharp decline in biodiversity and landscape diversity. The decreasing diversity in agricultural regions has strong impacts on soil quality, species richness and crop yield. In order to observe and analyse the biodiversity trend of recent years, a nationwide monitoring of biodiversity is conducted based on remote sensing and other spatial land use and land cover data within the framework of MonViA (German national project for the monitoring of biodiversity in agricultural landscapes). In this context, a set of biodiversity metrics is being developed to assess the status, changes and trends in land use and land cover at different temporal and spatial scales.

Since the usage of public crop type information like the European Land Parcel Information System (LPIS) is often restricted by data protection regulations and with the increasing availability of dense remote sensing imagery, crop type classifications represent crucial input data for agricultural biodiversity indicators. For Germany, various crop type classifications are available. Although these products contain map-specific accuracy metrics, they are only comparable to a limited extent from a user perspective because they differ in terms of the class catalogue and underlying validation strategies.

In this study, we investigate how well remote sensing-based crop type classification products can replace LPIS information. In order to take the user perspective into account, content tests are performed to determine the suitability along specific research questions. With the continuous implementation of an application-data-matrix, previous uses of data will be documented to enable further reuse. We use the data fitness for use approach in the first step to adapt biodiversity metrics to changing requirements and simplify the use of different input data. The analyses on the usage of diverse input data in the form of crop type classification products compared to LPIS information using several biodiversity metrics (e.g. Shannon Index) will be presented, which lead to best practice guidelines and algorithms for data fitness for use assessment.

Metabolite profiling of the hop flower (*Humulus Lupulus* L.) – focus on metabolites of medical interest

Böttger, Jana[1]; Waldinger, Martin[2]; Böttcher, Christoph[1]; Feiner, Alexander[2]; Riewe, David[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection, Berlin, Germany.
[2]Plant Science and Breeding, Simon H. Steiner, Hopfen GmbH, Mainburg, Germany.
Email of corresponding author: jana.boettger@julius-kuehn.de

The economic importance of hop is predominantly derived from its use in the brewing industry. As one of the four key ingredients of beer, the female flowers contribute significantly to its aroma. However, hop has also been acknowledged as medicinal plant for centuries. Phytotherapeutic hop preparations have long been used to treat nervous conditions, insomnia or indigestion. Hop contains several medicinally active components, with the focus of scientific attention primarily on prenylflavonoids. Numerous studies have already confirmed anti-inflammatory, antimicrobial and chemoprotective properties of xanthohumol (XN), and 8-prenylnaringinin (8-PN) has been shown to be a potent phytoestrogen.

Currently, the non-volatile metabolome of hop cones of different varieties, origins and harvest years is analyzed, and the contents of selected active ingredients and numerous other known and unknown metabolites will be determined. For this purpose, an LC-MS method was developed that allows quantification of these substances and simultaneous profiling.

Though the contents of the targets differ by orders of magnitude, the combination of reversed-phase liquid chromatography (RP-UHPLC) with mass spectrometry and UV-detection resulted in reproducible measurements of XN, 6- and 8-PN and multifidol glucoside on a single analysis platform. In addition, more than 4000 putative polar metabolites were detected in both positive and negative ionization mode of the mass spectrometer, allowing a comparative analysis of metabolite profiles.

Five sets of samples consisting of 995 specimens in total, including populations with high genetic and phenotypic variance as well as a F1-generation segregating with respect to XN-content are measured.

All profiled accessions were genotyped by sequencing in order to perform a genome wide association (GWAS) and to identify genetic markers related to metabolites or traits of interest in a future step.

The results of the study, genetic and metabolic markers for high value traits, should be used in marker assisted breeding programs for the development of high-quality hop products.

Development and optimization of resistance test methods to detect resistance to *Fusarium oxysporum* (Schlecht.) in asparagus (*Asparagus officinalis* L.)

Jacobi, Julia; Budahn, Holger; Nothnagel, Thomas; König, Janine

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Horticultural Crops, Quedlinburg, Germany.
Email of corresponding author: julia.jacobi@julius-kuehn.de

Fusarium oxysporum is a serious disease that causes root and crown rot in asparagus. Large asparagus growing areas in Europe are infected with *Fusarium oxysporum*, resulting in yield and quality losses at harvest. It cannot be effectively controlled by cultural or plant protection methods. Therefore, breeding resistant cultivars is an important strategy for managing *Fusarium oxysporum* in asparagus. The first step to achieve this goal is to establish a meaningful and reproducible resistance test.

A method for testing resistance of asparagus seedlings to *Fusarium oxysporum* has been developed and optimized to produce resistant basic material for breeding. It was tested on 11 asparagus cultivars and 3 wild relatives. Seedlings were inoculated with two strains of *Fusarium oxysporum* isolates, one low virulent and one high virulent isolate, and incubated for two weeks in a climate-controlled cabinet. Disease symptoms were quantified using a digital image analysis system (Lab Scanalyzer LS10) and PCR.

This resistance test will be further developed into a 'greenhouse test' to analyse resistance behaviour at later plant stages. In addition, an *in vitro* resistance test will be developed to allow test application under sterile conditions.

Quality Control of native pupal parasitoids against *Drosophila suzukii*

Martin, Jakob; Herz, Annette

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Biological Control, Dossenheim, Germany.
Email of corresponding author: jakob.martin@julius-kuehn.de

Drosophila suzukii Matsumura (Diptera: Drosophilidae) is a pest of fruit and berries, which has spread in the northern hemisphere in recent decades. It was first recorded in Germany in 2011. Unlike most other Drosophilids, the serrated ovipositor allows *D. suzukii* to oviposit underneath the skin of ripening and undamaged fruit. Larval feeding and secondary damage leads to the collapse of the fruit, rendering it unmarketable and creating considerable economic damage. The attack of undamaged fruit and the concealed life of the larva complicate pest control, and effective means of biological control to regulate *D. suzukii* do not exist yet. In its native range, *D. suzukii* is predominantly attacked by the cosmopolitan pupal parasitoids *Trichopria drosophilae* Perkins (Hymenoptera: Diapriidae) and *Pachycrepoideus vindemmiae* Rondani (Hymenoptera: Pteromalidae), as well as larval parasitoids. Both species are present in Germany, and European populations have shown to successfully parasitize *D. suzukii*. Within the project "ParaDrosu", a practical strategy for the usage of native pupal parasitoids to control *D. suzukii* in protected berry cultures is being developed, in collaboration with a producer for beneficial insects.

An important criteria for the success of augmentative releases is the quality of the released animals. The "IOBC Quality Control Guidelines for natural enemies" contain standardized methods to assess the quality of 18 species(-groups), among which are ten parasitoids. However, as the guidelines were last updated several years before the invasion of *D. suzukii*, they subsequently do not include its antagonists. Typical parameters for quality control of parasitoids include the quantity and ratio of live animals after shipping, the sex ratio, fecundity and longevity, furthermore, the testing frequency and sample size for each parameter is set. These tests need to be performed under species-specific standardized conditions. Maximum mortality is not always defined in the IOBC guidelines, but if so, it is ≤10%. The minimum ratio of female parasitoids is mostly given at 45% or 50% – an appropriate ratio for *T. drosophilae* and *P. vindemmiae* needs to be set. Longevity of females of both species is expected to be higher than a week after shipping. To test the fecundity, 30 single mated females need to be exposed for 24 h to a surplus of fresh host pupae under suitable conditions. For now, it is necessary to determine the fecundity over several days; data from mass-reared insects of the project partner, which were provided in summer of 2022, could help slim down the testing procedure and link it to other fitness parameters.

The project is supported by funds of the Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support programme (FKZ 2818805A19).

Pesticide residues in larval food jelly of the Western honey bee *Apis mellifera* – a review

Wüppenhorst, Karoline[1,2]; Eckert, Jakob H.[1,2]; Steinert, Michael[2]; Erler, Silvio[1,3]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Bee Protection, Braunschweig, Germany.
[2]Technische Universität Braunschweig, Institute for Microbiology, Braunschweig, Germany.
[3]Technische Universität Braunschweig, Zoological Institute, Braunschweig, Germany.
Email of corresponding author: karoline.wueppenhorst@julius-kuehn.de

Plant protection products like insecticides, fungicides, or herbicides are applied onto plants to protect them against pest insects or plant diseases. The collected and stored pollen and nectar serve as the nutritional resources of honey bees to produce the larval food which is fed to the larvae. Thus, contaminants could be transferred from plants, via nectar and pollen, to honey bees and further to larvae, and may lead to harmful risks. It has been proven in different studies that pesticides residues can be found in bee related products like wax, honey, and bee bread. We aimed to review and assess the amount of contaminants remaining in jelly, to evaluate factors influencing their occurrences as well as to deduce risk for larvae. Therefore, the current literature dealing with residue analysis of pesticides in larval food jelly was summarized and analyzed. Most of the studies focused on the detection of residues in royal jelly samples and found that 30 out of 176 analyzed pesticides remain detectable. They detected concentrations in a range of 0.005 to 3860.25 ng/g, which correspond to 0.00001% to 58% pesticide transfer into royal jelly. Only one study analyzed residues in worker jelly. The main factors influencing if residues remain detectable in jellies are the application and exposure methods. All detected concentrations were predominantly below the toxicological values for bee larvae. Nevertheless, there are no information about an impact on larval physiology and thus sub-lethal effects should not be neglected. The literature screening revealed that there are still knowledge gaps about the contamination pathway of pesticides, dilution or accumulation factors within hive, and degradation time in bee-related matrices. Those gaps should be filled to allow for sufficient protection levels of honey bees.

Session D

Pear fire blight resistance breeding research

Maag, Martin[1]; Muçaj, Buist[1]; Höfer, Monika[1]; Wensing, Annette[2]; Zetzsche, Holger[3]; Peil, Andreas[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Fruit Crops, Dresden, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Fruit Crops and Viticulture, Dossenheim, Germany.
[3]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
Email of corresponding author: andreas.peil@julius-kuehn.de

In Germany, the demand for both conventional and organic pears cannot currently be met from domestic production. The pear market is dominated by the varieties 'Alexander Lucas', 'Conference' ahead of 'Williams Christ', the 'Delicious of Charneux' and 'Clapp's Favourite'. These cultivars, as well as most other pear cultivars, are highly susceptible to the regulated non-quarantine pest (RNQP) *Erwinia amylovora*, which is the causal agent of fire blight, the most important disease in pear production. Since no suitable control measures are available in pear cultivation, the cultivation of resistant cultivars and the close and regular monitoring of pear plants and neighboring host plants are regarded as the best control options. Whereas in apple, intensive work is being done in various breeding programs to investigate fire blight resistance mechanisms and to breed resistant cultivars, efforts in pear are limited and available data are sparse. The project aims to contribute to improved effectiveness in breeding pear cultivars with resistance to fire blight, and to evaluate genetic resources of cultivated pear and *Pyrus* wild species to identify potential sources of resistance and make them available for breeding. The objectives are to analyze possible additive effects of resistance QTLs as well as to detect and test the efficacy of additional resistance loci, to use them in pear breeding using molecular markers, and to select pear genotypes with good resistance to fire blight. The development of molecular markers for effective resistance loci is the prerequisite for early selection in pear breeding for resistance to fire blight and acceleration for the development of new resistant cultivars.

Acknowledgements:

With support from
Federal Ministry of Food and Agriculture
by decision of the German Bundestag

Project manager
Federal Office for Agriculture and Food

Adapting the CERES model to simulate growth and production of cereal rye

Shawon, Ashifur R.[1]; Memic, Emir [2]; Bergjord Olsen, Anne K.[3]; Kottmann, Lorenz[4]; Hackauf, Bernd[5]; Feike, Til[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
[2]University of Hohenheim, Institute of Crop Science, Stuttgart, Germany.
[3]Norwegian Institute of Bioeconomy Research, Dep. of Grain and Forage Seed Agronomy, Norway.
[4]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
[5]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Agricultural Crops, Groß Lüsewitz, Germany.
Email of corresponding author: ashifur.shawon@julius-kuehn.de

Rye (*Secale cereale L.*) is primarily grown as an annual winter crop throughout the temperate zones of the northern hemisphere. Due to its high resource use efficiency, rather low input requirements and high resistance to frost and drought, it has good potential to support more sustainable crop production in the face of future climate change and rising food demand.

Process-based dynamic crop models are cutting-edge tools in current agronomic research by simulating crop growth, development, and yield under diverse soil, climate, and management conditions. They enable to evaluate the impacts of climate variability and management practices on agricultural production beyond limited field experiments. We choose to adapt the widely applied CSM CERES-wheat as a starting point for the rye model development, as rye is similar to wheat in terms of its morphological and physiological proper-ties.

We created large agronomic trial datasets of cultivar-specific data (rye cv. Palazzo and wheat cv. Winnetou) using value for cultivation and use (VCU) trial data from the Federal Plant Variety Office and state variety trials of Saxony-Anhalt (SVT). The datasets cover all relevant wheat and rye-growing regions in Germany, allowing us to scale up model calibration. We added in-season data from an N-regime trial in Kiel, Northern Germany, from 2008 to 2010, and the Julius Kuehn Institute in Braunschweig, Central Germany, from 2009 to 2010. Weather data for each experimental site were retrieved from the German weather service's climate data center (DWD), and soil data were derived from the European Soil Database (ESDB) v2.0, both data in 1km^2 grid scale.

The CERES-rye model showed satisfactory simulation accuracy regarding phenology, LAI, aboveground biomass, and tiller m-2 at harvest, unit grain weight, grain m-2 at harvest, and grain yield. Simulation-observation comparisons resulted in an RMSE of 3.3 days for emergence, 7.2 days for anthesis, and 7.3 days for harvest maturity date for the calibration dataset from the phenology part. From the growth and yield simulation, RMSE of 1.61 for LAI, 2468.7 kg ha^{-1} for biomass, 169.6 for tiller m^{-2}, 7708.0 for grain m^{-2}, 3.6 mg for unit grain weight, and 2182.7 kg ha^{-1} for grain yield.

CERES-rye is available to conduct various CSM-based analysis including the evaluation of crop management strategies, consideration in analyzing crop rotations in DSSAT, and assessing rye's suitability for cultivation in different growing environments.

Evaluation of the video-tracking method as a new approach for phenotyping using *Myzus persicae* and several wild potato species

Draack, Laura[1]; König, Janine[2]; Will, Torsten[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Horticultural Crops, Quedlinburg, Germany.
Email of corresponding author: laura.draack@julius-kuehn.de

Due to climate change and e.g. restriction of pesticide use, aphid populations are increasing. In addition to direct damage, aphids act as virus vectors. Thus, they have a great influence on plant health. Therefore, plant resistance against aphids is a promising approach in terms of integrated pest management. For resistance screening, there exist short-term methods for observing the interaction between plants and aphids, e.g. the Electrical Penetration Graph Technique (EPG), which focuses on feeding behaviour. Other methods such as insect fitness assays observe the interaction on a long term view. With all the methods, the information gain is enormous, but they are time and labor intensive. Thus, the gap between the throughput of genotyping methods and phenotyping methods is enormous and there is a need for new phenotyping methods.

In this context, we wanted to evaluate the recently introduced video-tracking technique (VT) for aphids and potatoes. This technique tracks the activity (moved distance) of the insects on leaf discs. Previous studies demonstrated, that the aphid's moved distance in a certain timespan and the resistance status of the plants correlate positively. Furthermore, the feeding behavior (EPG) of *Myzus persicae* was investigated to include an established method. There we were focus especially on the duration of the sieve element (SE) sap consumption. If an aphid consumes only a short time or even never SE sap, a plant is classified as resistant. A classification of genotypes (resistant or susceptible) was made for each method and the order of classification was then compared.

For the tests we selected wild potatoes show a huge phenotypic variation, including glandular trichomes on the leaf surface whose secretions may negatively affect aphid attraction, as potential resistance resources. Seven wild potato species (*Solanum bulbucastanum, S. verrucosum, S. chacoenese, S. andigena, S. pennitasectum*, *S. etuberosum, S. stoloniferum*) and one susceptible cultivar as control (*Desiree*) were used in that study.

For both technical approaches, we detected differences for different wild potato species, indicating resistance against *M. persicae*. In addition, the order of genotypes in terms of resistance resistance status was the same for both techniques. Aphid movement was higher on potato genotypes where the duration of the SE-ingestion was shorter compared to the other genotypes, and the other way around. So, we were able to validate VT as a new useful medium to do high-throughput phenotyping for research on aphid resistance in potato.

Strip cropping with oilseed rape and wheat – a chance for biodiversity at high yields and stabile incomes

Grote, Michelle[1]; Breustedt, Gunnar[2]; Gabriel, Doreen[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
[2]Christian-Albrecht University of Kiel, Institute for Agricultural Economics, Kiel, Germany.
Email of corresponding author: michelle.grote@julius-kuehn.de

The social objectives of modern agriculture are located in an area of conflict between food security, biodiversity, environmental protection and income for farmers. There is increasing awareness for the need to transform the conventional, pesticide-based management to diversified production systems that promote biodiversity and associated ecosystem services such as pollination and natural pest control. Innovative strip cropping systems can be a component of this strategy to foster sustainable agriculture with high yields.

Strip cropping is a diversified production system where different crops are simultaneously grown in adjacent strips on the same field. Large uniform fields are split up into several small units, thereby increasing boundary line density and spatial and temporal variability in the field. By increasing the complexity of habitat conditions for e.g. weeds, insects, but also birds, strip cropping has the potential to promote the biodiversity and ecosystem services through turnover effects, i.e. beta-diversity, and spillover processes. Moreover strips can act as boundaries thereby preventing the spread of diseases.

The objective of this study is to assess the effects of the strip-cropping system oilseed rape-wheat on in-field biodiversity, associated ecosystem services, pests and crop yield.

The strip-cropping system was established on 14 conventionally managed farms in Lower Saxony and Saxony-Anhalt with oilseed rape and winter wheat as strip crops. These crops are of high agronomic and economic importance. Strip cropping fields contained seven alternating strips of 21 – 36 meter width. Each farmer also provided an oilseed rape and wheat field nearby, which served as reference. Crop specific pesticides were applied during the growing period. An insecticide-free window was implemented in each field.

Biodiversity and associated ecosystem services were surveyed using standardized methodology. Arable weeds and pollinating insects were counted along transects, farmland birds were recorded visually and by their songs and predatory insects such as carabid beetles were caught using pitfall traps. Pests such as cereal aphids, pollen beetles, rape stem weevils and others, the damage caused by pests and plant diseases together with yield were also quantified. Sampling was conducted between March and July 2022 and will be repeated in 2023. Currently specimens are sorted and identified in the laboratory. Data will be analysed using generalized linear mixed effect models.

Based on the knowledge gained, the design of an EcoScheme for the promotion of strip cropping will be developed.

Sequencing the genome of a European *Diplocarpon coronariae* strain

Richter, Sophie[1]; Oberhänsli, Thomas[2], Patocchi, Andrea[3]; Bohr, Anne[4]; Buchleither, Sascha[4]; Flachowsky, Henryk[1]; Wöhner, Thomas[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Fruit Crops, Dresden, Germany.
[2]Department of Crop Sciences, Research Institute of Organic Agriculture (FiBL), Frick, Switzerland.
[3]Agroscope, Research Division Plant Breeding, Breeding Research Group, Waedenswil, Switzerland.
[4]Competence Centre of Fruit Growing Lake Constance (KOB), Ravensburg-Bavendorf, Germany.
Email of corresponding author: sophie.richter@julius-kuehn.de

Diplocarpon coronariae ((Ellis and Davis) Wöhner and Rossmann) is a fungal pathogen that causes apple blotch disease and occurs in meadow orchards as well as in organic and integrated fruit cultivation. The fungus has spread in Europe since the last 15 years. Only a few information is known about the biology and pathogenicity of the organism. A valuable source on infection mechanisms can be provided e.g. by genome sequences. Recently, the sequence of a Chinese isolate (NL1) of *D. coronariae* was published. The sequence information of this strain indicates that secondary metabolites such as toxins and inhibitor proteins play a role in host colonization. Currently, no sequence of a European isolate exists.

In this study we sequenced a *D. coronariae* strain (Fu0034) obtained from Dresden, Germany. After isolation from an infected leaf and cultivation on PCDA media, the DNA was isolated from grown mycelia after three weeks. The DNA was sequenced with an Illumina NovaSeq sequencer (NovaSeq 6000 S4 PE150 XP). 21,037,227 raw reads were obtained. After cleaning and mapping of high quality reads a total of 94.1% reads were aligned to the reference genome NL1 with 91x coverage. GATKs Haplotype caller detected 477,451 variants (445,890 SNP, 31,561 InDel). A consensus sequence of Fu0034 was calculated with the software bcftools consensus using the variant information and the reference sequence NL1. The final draft of Fu0034 contained 589 contigs with a total length of 50,283,537 bp and a N50 of 231,484 bp. The BUSCO analysis on genome completeness resulted in 98.4%.

The results of this study provide a basic tool for studying the genome structure, and sequence variation of a European pathotype from the apple blotch pathogen *D. coronariae.* Future analysis like structural and functional genome annotation will give deeper insights into the pathogen biology and host colonization mechanisms.

Phytotyper - Identification of phytopathogenic microorganisms by MALDI Biotyper

Binmöller, Laura; Wensing, Annette

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Fruit Crops and Viticulture, Dossenheim, Germany.
Email of corresponding author: laura.binmoeller@julius-kuehn.de

Bacterial plant diseases are a major concern, therefore prevention and control of epidemics relies on fast and reliable diagnostics. One diagnostic system for bacterial species identification, which became well established in clinical microbiology over the last years due to short processing time, high throughput, and universality of the protocol, is MALDI Biotyper.

The MALDI-TOF MS based system generates mass spectra of the proteins from either whole bacterial cells or cell extracts. The protein peak patterns originate from the most abundant proteins in the cells and are specific for the respective bacteria. Taxonomic identification of microorganisms is possible by matching the generated peak pattern against the peak lists of spectra from known bacterial isolates. Depending on the Taxa and the number of reference spectra, resolution can be at the genus-, group-, or species-level. A database containing around 9,600 reference spectra is provided by the Biotyper manufacturer. However, in the manufacturer's database coverage of microorganisms in phytomedical context is low and more random, than practice-oriented.

Therefore, the aim of the BMEL-funded Phytotyper project is to improve MALDI-TOF MS based diagnostic methods for plant-health-related bacteria. The first part of the project includes the build-up of a contextual reference database with coverage of relevant plant pathogenicbacteria and non-pathogenic accompanying microorganisms from diverse samples and species for facilitated diagnostics. Simultaneously, information on microbial diversity in different plant production systems will be obtained. Furthermore, for heterogenous species like the *Pseudomonas syringae* group, for which with the manufacturers database assignment is rarely possible on species-, let alone on pathovar-level, higher resolution will be achieved by higher coverage in the database, as higher coverage in the database leads to higher resolution in the species identification.

The advantage of the Biotyper technique is the possible detection of all cultivable microorganisms on a plant sample. This facilitates diagnostics for samples in which saprophytic bacteria mask the actual pathogen, or in which conventional diagnostic methods cannot identify a distinct pathogen. Also, isolates for which no reference is available can be grouped according to their similarity and, without further characterization a reference can be created. Thus, these unidentified isolates can already be used for diagnostic purposes. In addition, relevant yet unidentified isolates will be further characterized by either Sanger sequencing or multilocus sequence analysis (MLSA).

To date, our database consists of 486 entries from six different plant samples and several microbiological isolates from routine diagnostics. For half of these entries identification was possible at least to the genus level.

Session E

Drought stress response of barley genotypes treated with biologicals

Töpfer, Veronic[1]; Hamburger, Susanne[2]; Linkies, Ada[2]; Schmidt, Annegret[2]; Meziane, Asmae[3]; Feike, Tile[3]; Matros, Andrea[1]; Stahl, Andreas[1]; Wehner, Gwendolin[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Biological Control, Dossenheim, Germany.
[3]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
Email of corresponding author: veronic.graetz@julius-kuehn.de

This year, almost 50% of the European agricultural area suffered from drought stress. The tendency for the next years is constantly increasing. Therefore, plants develop different strategies to adapt to drought stress like in morphological, physiological and molecular pathways. In addition to drought stress, there are other challenges to handle with like the decrease of conventional plant protection products due to their negative ecological consequences. Thus, biologicals are gaining more importance because of their environment-friendly property. Biologicals are products containing natural substances and/or microorganisms leading to increasing abiotic and biotic stress tolerance. The aim of this study is to investigate drought stress tolerance in various barley genotypes (*Hordeum vulgare* L) and to analyse the effect of application of biologicals on these genotypes under drought stress.

First, eleven diverse reacting genotypes were selected out of 200 accessions from the spring barley IPK-SB224 panel (Genobar) for greenhouse and field experiments. Drought stress was induced by 20% water capacity at the third-leaf stage for six weeks followed by a two weeks re-watering phase to investigate the recovery ability with and without treatment of biologicals. During drought stress and re-watering phase, chlorophyll content and stomatal conductance were measured and water use efficiency was calculated for this period. Flag leaves were collected to examine the osmolality, proline content and soluble sugars as well as for qRT-PCR analysis of several relevant drought stress genes. Moreover, mature plants were harvested and yield parameters like kernel biomass were acquired. Additionally, root morphology of the eleven genotypes was analysed in a hydroponic system by application of PEG6000 as an osmotic stressor.

First results indicate a high significant ($p<0.01$) correlation of plant and kernel biomass between greenhouse and filed experiment of 0.6 and 0.54, respectively. Most significant correlation with the plant biomass was calculated for water use efficiency (0.93) and water use (0.72) under greenhouse conditions. Preliminary results of the analysis of biologicals under drought stress treatment show an increase in biomass up to 78% by applying extract of *Arcitum lappa* and 130% by the extract of *Reynoutria sachalinensis*. Results of the root analyses indicate that all root related parameters such as root biomass, length and volume are significantly ($p<0.001$) affected by PEG treatment and genotype.

Next steps are to verify the results of drought adaptation under biological treatments in a greenhouse experiment and in field experiments in 2023.

Struvite – Agronomic evaluation of a recycled phosphorus fertilizer

Keßeler, Paul M.; Bloem, Elke; Kratz, Sylvia

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
Email of corresponding author: paul.kesseler@julius-kuehn.de

Phosphorus (P) is an essential and non-substitutable plant nutrient required for high-yield agriculture. However, phosphate ore deposits are finite and increasingly contaminated with cadmium and uranium. The EU is completely dependent on imports of this limited resource, and has therefore classified P as a critical raw material in 2014. Recycling of P from alternative sources like P-rich waste streams (wastewater and sewage sludge) can contribute to substitute some of the imports and meet future demand for P.

One P recycling product from wastewater treatment is struvite ($MgNH_4PO_4 * 6 H_2O$), a hardly water-soluble but fully plant available salt.

The aim is to use the struvite as a fertilizer in agriculture, thus closing nutrient cycles. As part of the BMBF-project 'RePhoR - P-Net', we are investigating the agronomic performance, as well as the nutrient and contaminant (heavy metal and antibiotics) levels of different struvites and struvite-based fertilizers in comparison with conventional P fertilizers. The struvite-based fertilizers used here were developed within the project and include ground pure struvite, pure struvite in pelletized and granular form, as well as struvite blended with a mineral compound fertilizer in pellet form.

In a three-month greenhouse pot trial with *Lolium multiflorum,* ground pure struvite showed a fertilization effect comparable to conventional triplesuperphosphate in two different low-P growth substrate mixtures, independent of soil pH, over all three cuts.

Based on these results, nine large-scale on-farm trials with a duration of one to three years were set up with pelletized and granulated struvite-based fertilizers and the farmers' standard fertilization as a reference. The fertilizers were placed close to the seed during sowing, applying the sowing technique of the respective farmers. In contrast to the greenhouse pot trial, the on-farm trials did not show a clear effect of struvite-based fertilizers on dry matter yield (DMY) of maize/corn and potatoes. Compared to the reference fertilizer, struvite fertilization resulted in significantly higher DMYs on some experimental fields but significantly lower DMYs on others.

These variable results are probably related to different soil pH and soil P levels of the experimental fields. To clarify this, a further greenhouse pot trial with granulated and pelletized struvite fertilizers under defined soil conditions will be carried out in the course of the project.

Assessment of climate change impact on mid-century wheat production in Germany using multi-model-ensembles

Jorzig, Christian[1]; Shawon, Ashifur R.[1]; Memic, Emir[2]; Dominic, Anto R.[1]; de Kock, Arno[1]; Strassemeyer, Jörn[1]; Golla, Burkhard[1]; Feike, Til[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
[2]Working Group Cropping Systems and Modelling (340), University of Hohenheim, Germany.
Email of corresponding author: christian.jorzig@julius-kuehn.de

Process-based crop simulation models (CSM) serve as valuable tools to assess potential crop production under future climate conditions. They support the development and evaluation of suitable adaptation strategies in crop management to address future risk factors like increased temperature and altered precipitation patterns. The use of a multi-model-ensemble (MME) approach in crop modelling can increase simulation robustness compared to single model outputs. This study aims to assess mid-century mean yield development and yield stability of winter wheat (*Triticum aestivum*) under different climate scenarios for important wheat production regions in Germany.

We use the three wheat crop models CERES, CROPSIM and Nwheat embedded in the Decision Support System for Agrotechnology Transfer (DSSAT). This enables depiction of the CSM-specific uncertainties in addition to the climate model-related uncertainties allowing a more robust evaluation of potential future wheat yields. After cultivar-specific calibration and evaluation of the three models to fitting observed and simulated phenology, growth and yield parameters, we simulate yields in 2031-2060 and the reference period 1971-2000 using daily weather data of the 17 climate scenarios of the core ensemble of the German weather service. In addition, the simulations for 2031-2060 are performed with constant mean CO_2-level of 1971-2000 in order to quantify and evaluate the CO_2 fertilization effect on future yield development. These virtual experiments are executed for a range of representative wheat production sites that cover the multitude of soil types and climate conditions present in Germany.

We see that for all sites and climate scenarios the multi-model-ensemble projects higher yields in the future than in the past, with a mean yield increase of around 12% for RCP2.6 and RCP4.5 up to 15% for RCP8.5. Most of the projected yield increase is driven by the increasing atmospheric CO_2 concentrations, which are highest under RCP8.5 and lowest under RCP2.6. The results show that the yield advances due to the CO_2 fertilization effect are likely going to decrease in future. This indicates that other, non CO_2-related climatic changes (i.e., temperature, precipitation) are going to excerpt an increasingly negative impact on future yield formation of winter wheat. The study demonstrates the potential and necessity of using MME both, with regard to climate change scenarios and crop models, especially when intended for policy advice.

Antago-*Senecio*: local and specialized biological control agents against poisonous tansy ragwort (*Jacobaea vulgaris*, syn. *Senecio jacobaea*) in grasslands

Müller, Sophie[1]; Herz, Annette[1]; Ströde, Peter[2]; Kleinebecker, Till[3]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Biological Control, Dossenheim, Germany.
[2]Justus-Liebig-University Giessen, Professorship of Organic Farming, Giessen, Germany.
[3]Justus-Liebig-University Giessen, Division of Landscape Ecology and Landscape Planning, Giessen, Germany.
Email of corresponding author: sophie.mueller@julius-kuehn.de

The rising number of tansy ragwort (*Jacobaea vulgaris* Gaertn., syn.: *Senecio jacobaea* L.) in grassland, especially in extensive ones, is highly problematic for grazing livestock due to the poisonous impact of pyrrolizidine alkaloids in these plants. This phenomenon also exacerbate the use of those ragwort-rich grasslands for grazing or hay and silage production. Current management and control practices are time consuming and inefficient wherefore an innovative and self-regulating method is in need to secure the livelihood of farmers and the preservation of diverse and protected grasslands. Therefore, one aim of the EIP-Agri-Project "Antago-*Senecio*" is finding local and specialized herbivorous insects as potential biological control agents for the regulation of tansy ragwort. Here, the well-known cinnabar moth, *Tyria jacobaeae* L. (Lepidoptera, Arctiidae) and ragwort flea beetle, *Longitarsus jacobaeae* Waterhouse (Coleoptera: Chrysomelidae), as well as the less studied ragwort crown boring moth, *Cochylis atricapitana* Stephens (Lepidoptera: Cochylidae) may be an option.

First collection of these insects were performed in the season 2022 and more than 150 larvae of *T. jacobaeae* were collected from several locations. However, at least one population was infected by microsporidia and only 26 % of collected insects survived and pupated successfully. The mean weight of the 44 surviving *Tyria*-pupae is 142.59 ± 21.81 mg and represents a solid weight for further development. Additionally, *L. jacobaeae* and *C. atricapitana* were collected in the field and are currently reared in the greenhouse. Laboratory tests are planned for the establishment of successful rearing technique as well as feeding trials to evaluate the harmful effects of the potential biological control agents. Besides their suitability for the control of *J. vulgaris*, also other ragwort species like *Jacobaea aquatica* G. Gaertn., B. Mey. & Scherb (syn.: *Senecio aquaticus* Hill), *Jacobaea erucifolia* G. Gaertn., B. Mey. & Scherb (syn.: *Senecio erucifolius* L.) and *Senecio inaequidens* D.C. are investigated. Moreover, field tests in the Westerwald in Hessia and Rhineland-Palatinate will be conducted and will complement the laboratory studies. Finally, the result will be used as basis to evaluate the potential of these herbivorous insects to regulate the dominance of ragwort in extensive grasslands as well as perspectives of their long-term establishment and application processes in grasslands.

DNA metabarcoding for comparative analyses of copper effects on the grapevine phyllosphere mycobiome in organic viticulture

Ditton, Yannick; Fischer, Michael; Behrens, Falk H.

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Fruit Crops and Viticulture, Siebeldingen, Germany.
Email of corresponding author: yannick.ditton@julius-kuehn.de

Plant protection in organic viticulture strongly depends on the use of copper to control downy mildew (*Plasmopara viticola*), even though its application is controversial due to its detrimental environmental impacts. Investigations on copper toxicity focus mainly on soil microbiota but little is known about its effects on leaf colonizing microorganisms.

The VITIFIT consortium project, which investigates strategies to maintain grapevine health while reducing copper application rates in organic viticulture, includes a focus on analyzing potential effects of copper on the overall phyllosphere mycobiome. Because copper is not specific in its action as a fungicide, off-target effects on various plant-associated fungi are expected. Therefore, vineyards of strategy trials were used to investigate how fungal diversity and the abundance of individual fungi of the grapevine leaf surface mycobiome are affected by the application of copper. Metabarcoding of the ITS1 region was applied to identify fungal OTUs from leaf surfaces by analyzing leaf wash samples.

The results will give insights into copper-induced changes of the fungal community structure. Additionally, specific taxa, which are highly affected in their relative abundance in response to cooper treatments can be identified.

Poster

Effect of elevated CO_2 concentrations on leaf rust resistance in a broad panel of European winter wheat varieties

Krößmann, Jasper; Serfling, Albrecht; Stahl, Andreas

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
Email of corresponding author: jasper.kroessmann@julius-kuehn.de

Common wheat (*Triticum aestivum L.*) is one of the most important crops for human nutrition worldwide. To ensure food security, wheat production needs to be increased by more than 50% by 2050. However, leaf rust infections caused by *Puccinia triticina* can lead to yield losses up to 60%. Breeding and cultivation of resistant varieties is the most effective and environmental friendly solution to secure yield.

The atmospheric CO_2 concentration has almost doubled since the pre-industrial time and it can be firmly assumed, that the CO_2 concentration will continue to increase in the years to come.

Although a large number of studies analyzed the effects of an elevated atmospheric CO_2 concentration, to the best of our knowledge no study considered the effects of elevated atmospheric CO_2 concertation (eCO_2) on infection and resistance behavior of a larger number of varieties yet.

In the WheatFACE project, we strive to obtain a better understanding of eCO_2 on the leaf rust resistance behavior of winter wheat.

We address the question whether eCO_2 result in an increased susceptibility, since the CO_2 fertilization increases biomass growth, or whether the penetration of the fungus is reduced due to the possibly closed stomata or an improved vitality of the plants. To analyze this, about 200 winter wheat cultivars are exposed to divergent CO_2 concentrations (410 vs. 800 ppm) and are inoculated with a particularly aggressive leaf rust isolate.

Evaluation of leaf rust infestation is done both by manual scoring and by digital quantification of infected leaf area using high-throughput technique. The results give hint about the influence of eCO_2 on the extent and intensity of leaf rust infection in wheat.

Based on these results, ten varieties were selected that showed the most contrasting resistance behavior at divergent CO_2 concentrations. These will be grown over the next two years in a free air carbon dioxide enrichment (FACE) facility under field conditions. Moreover, a core set will be investigated on a gravimetric phenotyping platform to investigate potential links of drought stress response and leaf rust infection.

The impact of 5G technologies on agriculture

Dillschneider, Eva-Marie; Wegener, Jens Karl; von Hörsten, Dieter

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Application Techniques in Plant Protection, Braunschweig, Germany.
Email of corresponding author: eva-marie.dillschneider@julius-kuehn.de

Digitization is becoming increasingly important, as more and more farmers are turning to digital solutions. Digitization includes, among many other functions, the automation of processes through the networking of different digital technologies, information and people. This allows the entire value chain to be optimized, as large volumes of data can be collected, processed and evaluated. In agriculture, data can be collected for example by sensors on tractors, harvesters or robots. Through evaluation, for example by artificial intelligence (AI), this data can provide additional and more specific information about the current demand for crop protection and fertilizatioin, soil properties or yields.

In the cooperation project entitled "5G - Smart Country", through the new 5G technology, data will be collected in both forestry and agriculture. The aim is to develop and test 5G applications that facilitate data collection and transfer.

The institute for application techniques in plant protection is investigating the practical application of the “Spot Farming” concept in the "Smart Farming" subproject. For this purpose, the fields are divided into homogeneous subareas (spots) on the basis of soil types, erosion potentials, topography and irradiation among other factors. To these specific attributes of a spot a crop rotation can be grown, that fits to the individual attributes of the spot in best way. Spots can also offer further functions than productivity in context to surrounding landscape. This can be for example hegdes and ditches as elements against water and wind erosion or as structural elements with ecological functions. However, this means that less land is available for productivity and these structures are smaller. Therefore, the spots must have the same or higher productivity and be managed accordingly more efficiently. One way to achieve this is to plant in different row spacing or seeding patterns, such as an equilateral triangle. Furthermore, the areas produced through such methods are small-scale, it will not be possible to manage them with modern, large-scale agricultural equipment. Therefore, small autonomous field robots must be integrated.

In the coming trial year, sugar beet will be sown GPS supported. This is done by using the “Dino” field robot from the Naïo company. Additionally mechanic weed control will be carried out with the robot. The goal is to collect more information about the creation of spots and their effects, as well as the application and implementation of robotics in agriculture based on the 5G technolgie.

Influence of seeding time on developmental and yield traits in anise (*Pimpinella anisum*)

Stache, Anne-Marie; Hähnel, Urs; Marthe, Frank

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Breeding Research on Horticultural Crops, Quedlinburg, Germany.
Email of corresponding author: anne-marie.stache@julius-kuehn.de

Anise (*Pimpinella anisum*) originates from the Mediterranean region, there most of the production is also situated. There is a high demand on high quality raw material for medicinal purposes and consumption in Germany, but nearly no production. Due to the climate change, Germany is facing more often dry and hot summers, which becomes increasingly problematic for traditional grown crops. So growing drought tolerant crops, like anise, could be a possibility to stabilize yields and income.

Since anise is a quite new crop to Germany, experience in handling the crop is very rare. Defining the optimal seeding time point is important for establishing a good crop in the field.

In a field experiment over two years, it was tested how the seeding time point influences developmental and yield traits. It could be shown, that late sowing (May, June) leads to delayed emergence and lower germination rates due to water scarcity. Earlier sowing dates (March, April) showed different emerging times, depending on the (soil) temperature. The plants itself, were tolerant against cold temperatures. Drought and heat during spring and early summer forces the farmer to sow as early as possible to use the available water in the soil.

Furthermore, the results showed, that an early sowing date is advantageous because the available water (soil and precipitation) can be used for establishing a homogeneous crop with less missing plants. A dense and closed crop is important to suppress weed grow.

Besides, flowering starts earlier than in later sown fields. This can be a reason for the higher essential oil content in early sown plots (2021). And consequently harvesting is also earlier in summer, which leads to a fast and homogeneous ripening. This could help to avoid cold and wet conditions during the ripening time. This weather conditions are problematic. It causes the seed to turn dark. Dark coloured seeds are of minor quality and less usable for consumption.

Genotypes tolerating cold temperatures during germination could be favourable for German cropping conditions. This would lead to a faster emergence. Thus, seeding and emergence can be better planned. This would also be advantageous for the weed management during crop establishment.

The proof of safe use for the practical application of a urease inhibitor to mitigate ammonia emissions in cattle barns

Ehmke, Annika[1]; Hartung, Eberhard[2]; Melfsen, Andreas[2]; Wegener, Jens Karl[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Application Techniques in Plant Protection, Braunschweig, Germany.
[2]University of Kiel, Institute of Agricultural Engineering, Kiel, Germany.
Email of corresponding author: annika.ehmke@julius-kuehn.de

Ammonia emissions from cattle farming can be significantly reduced by using urease inhibitor (UI). To implement the use of a urease inhibitor in cattle barns, two application techniques (robotic manure scraper and flexible hose drop system) will be developed for automatically daily dosage, mixing, and application of the UI on the stable floor. In addition, proof of safe use for animals and humans must be provided. These goals are pursued in the project Prax-REDUCE.

For proof of safe use, inhalative and dermal exposure data are needed. Fluorometry is a methodical approach measuring these exposures. Instead of the UI, the fluorescent dye pyranine is used for data collection.

Laboratory tests have shown that Tyvek and nylon filters are suitable materials for detecting dermal and inhalative exposures. Based on animal behavioral studies, different exposure scenarios for both application techniques are simulated first in laboratory tests and afterward in practical trials in the cattle barn.

In dermal exposure measurements, a model cow is covered with Tyvek at the expected exposed parts of the body. For the detection of inhalative exposures, an aerosol collection pump with nylon filters as collector is used, which corresponds to the respiratory demand of a resting cow of approximately 650 kg. The volume flow is 100 l/min.

Subsequently, the pyranine concentrations collected on Tyvek as well as nylon filters can be determined on the Spectro fluorophotometer. The measured concentration can be converted into the spray liquid quantity or the UI quantity, which is relevant for the classification of the risk.

The first practical tests in the cattle barn showed good results regarding the applied method and used materials. Further exposure measurements will be performed in the cattle barn to confirm the reproducibility of the method with a higher data density.

SPITFIRE - Screening of *Pisum sativum* accessions for PNYDV resistance

Tan, Shin-Yee[1]; Grausgruber-Gröger, Sabine[2]; Lohwasser, Ulrike[3]; Gaafar, Yahya[4]; Ziebell, Heiko[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Epidemiology and Pathogen Diagnostics, Braunschweig, Germany.
[2]Austrian Agency for Health and Food Safety (AGES), Institute for Sustainable Plant Production, Department for Molecular Diagnostics of Plant Diseases, Vienna, Austria.
[3]Leibniz Institute of Plant Genetics and Crop Plant Research (IPK), Department of Genebank, Research Group Resources Genetics and Reproduction, Gatersleben, Germany.
[4]Centre for Plant Health, Canadian Food Inspection Agency, North Saanich, Canada.
Email of corresponding author: shin-yee.tan@julius-kuehn.de

Pea (*Pisum sativum*) is a leguminous crop that is generally used for livestock feed and human consumption. It is also commonly used to improve soil fertility through intercropping and crop rotation in agricultural practices. This high value vegetable has a steady gradual growth of demand in Europe, and it is one of the major vegetables in Germany, produced on 5,656 hectares in 2021 (BLE, 2022). However, the pea production in both Germany and Austria suffers from the infection of a nanovirus, pea necrotic yellow dwarf virus (PNYDV). PNYDV is a multipartite, single-stranded, circular DNA virus and transmitted by aphids in a circulative, persistent manner (Gaafar and Ziebell, 2020). The first identification of PNYDV in pea was in 2009 from a field in Saxony-Anhalt, Germany (Grigoras *et al.*, 2010); then subsequently detected in Austria (Grigoras *et al.*, 2014; Gaafar *et al.*, 2016), the Netherlands (Gaafar *et al.*, 2017) and Denmark (Gaafar *et al.*, 2018). Infected peas show symptoms of leaf rolling, chlorosis, stunted growth, shorter nodes, poorly developed pods and necrosis; sometimes also complete plant death can occur thus leading to severe yield losses as also observed for other legumes (Saucke *et al.*, 2019). Currently, the control of virus vectors using pesticides is often expensive and not efficient, especially with the concerns for sustainability and environmental issues. Moreover, development of pesticide resistance was also reported for some insect vectors. Therefore, virus-resistant plant varieties are needed for sustainable production of pea crops. As to date no commercial PNYDV-resistant pea lines are known, the SPITFIRE project aims to identify genetic resources of peas that may confer resistance or at least tolerance to PNYDV infection. In collaboration with the Genebank for Plant Genetic Resources (IPK Gatersleben, Germany) and pea breeders, the Julius Kühn-Institut (JKI) and the Austrian Agency for Health and Food Safety (AGES) are screening pea varieties, land races, heritage cultivars and wild *Pisum* species for potential PNYDV resistance.

Using electron microscopy to uncover latent tobamovirus

Ilyas, Rabia; Gaafar, Yahya Z.A.; Ziebell, Heiko; Richert-Pöggeler, Katja R.

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Epidemiology and Pathogen Diagnostics, Braunschweig, Germany.
Email of corresponding author: rabia.ilyas@julius-kuehn.de

A combination of electron microscopy and genome sequencing is highly efficient in screening for latent virus infections independent of the virus morphology or genome. One example is hoya tobamovirus-2 (HoTV-2 genbank accession number: MT750216.1) that has been reported from symptomatic mixed infected samples in 2011 and also as single, asymptomatic, infection in several *Hoya* species in Germany. The virus induces no symptoms in experimental host plants including *Chenopodium quinoa, N. tabacum* 'Xanthi nc', *N. benthamiana* and *N. tabacum* 'Samsun nn'. 14 days post inoculation, plant sap homogenates were examined using negative staining. Rod shaped virions of 300nm length were detected in newly developing leaves, confirming systemic infection. The virions' morphology and size indicated presence of a tobamovirus. The virus titer was lower when compared to tobacco mosaic virus (TMV) infected plants. For virus species identification, RNA sequencing data were scanned for virus specific sequences. The assembled virus genome could be assigned to the genus *Tobamovirus*. Phylogenetic analysis showed it is closely related to Youcai mosaic virus (YoMV). Therefore, polyclonal antisera for YoMV (DSMZ number AS-0527) was used in immuno-electron microscopy. The heterologous antiserum reacted with HoTV-2, while other tobamovirus antisera used in routine tobamovirus detection did not. The binding of antibodies along the virion was irregular when compared to TMV and its homologous antisera. Mixed infected *Hoya* plants and HoTV-2 infected *N. benthamiana* leaves were embedded to study the ultrastructure of infected plants displaying latency linking *in situ* HoTV-2 structures.

Projected wheat and maize yields in Germany in 2050 – a meta-analysis

Bittner, Marlene; Riedesel, Ludwig; Feike, Til

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
Email of corresponding author: marlene.bittner@julius-kuehn.de

Climate change constitutes a major threat to the future of our planet. To be able to adapt to climate change and develop climate resilient cropping systems it is crucial to first assess climate change impact on crop production. With more and more studies published over the past two decades, increasing evidence is available regarding the potential impact of climate-related changes on agricultural productivity. However, there is a lack of an integrated assessment of the current state of knowledge regarding climate change impact on crop yields in 2050 in Germany. Therefore, this study aims to summarize and analyse all relevant literature that project yields of winter wheat and silage maize in Germany in the mid-21st century conducting a meta-analysis.

Twenty peer-reviewed papers and reports were selected following a systematic literature review. Available data were extracted from all studies covering change in yield, temperature, precipitation and CO2 level, as well as information on the study location, modelling approach and considered climate scenario. In total 328 and 478 data points on yield change available for maize and wheat, respectively. Descriptive analysis was used to display relative yield changes according to crop, region, modelling approach and whether or not CO2 effects were included. Furthermore, a local linear quantile regression model and linear mixed effects model were conducted to describe the relationship between relative yield changes and changes in mean temperature, mean precipitation, and CO2 level and to determine and quantify the effect of the three climate variables on yield change.

The descriptive analysis shows that the vast majority of projected changes in average yields in 2050 vary from -10% to +10% for both crops, while wheat yields tend to increase and maize yields tend to slightly decrease. Moreover, maize is projected to experience mostly negative mean yield changes in eastern and southern Germany. Also statistical models project merely negative yield developments for maize. On the other side, yield increases are projected all-over Germany for wheat. Quantile regression revealed more distinct relations of CO2-, temperature- and precipitation-change on future yields in wheat compared to maize. The linear mixed-effects model confirmed these results with regard to precipitation showing a strong positive relation with wheat yields but a rather indistinct effect on maize yields. Accordingly, no effect was found for temperature change on maize yields, but an exponentially negative effect on wheat yields, i.e., slight temperature increase acted positive, while an increase >2°C acted negative on future yields. An increase in CO2 level excerpts positive effects on yields for both crops, with the increase more prominent for wheat than for maize.

Predator-prey relationships in NOcsPS winter wheat cultivation systems

Gitzel, Julia; Kühne, Stefan

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
Email of corresponding author: Julia.gitzel@julius-kuehn.de

NOcsPS is an interdisciplinary research project dealing with different intensive agricultural cultivation systems without use of chemical-synthetic pesticides.

The aim of the subproject is to examine, if the avoidance of synthetic pesticides can stabilize the function of the predator-prey relationship between the predatory flies and insect pests. For this purpose, five bioindicators were considered: hoverflies (Syrphidae), robber flies (Asilidae), dance flies (Hybotidae), ladybirds (Coccinellidae) and bees (Apoidea). Particular attention is paid to predatory flies, as these are natural antagonists of plant-damaging midges and flies (e.g. wheat gall midge, stalk and leaf miner flies). The small dance flies (Hybotidae), which are only 3 mm in size, are particularly sensitive to synthetic pesticides. They can recover less quickly through immigration. Therefore, this group of flies is suitable both as a new indicator for agrobiodiversity and for mapping the effects of different cultivation systems on predator-prey relationships.

The experiment was set up as a randomized block design in 2019. It consists of five wheat variants with four repetitions each. There are three ecological variants (one etablished organic variant since 1995, two organic variants since 2019 with two different varieties of wheat). Additionally, there are two other variants: NOcsPS II (no synthetically pesticides, adapted fertilization) and the conventional wheat variant.

The entomological investigations are carried out with sweeping nets, photoelectors, yellow traps and soil activity tests. Sampling takes place from the beginning of May to the end of June. The trapped insects are determined taxonomically. In addition to comparing the arthropod biomass and insect numbers, the samples are compared with regard to the diversity (shannon index, evenness) of different taxocoenoses. A taxonomic determination of all caught insects is carried out at family, genus or species level.

After two years of trials, the effects of cultivation intensity on biodiversity parameters are still inconsistent. However, the absence of pesticides tends to have positive effects on biodiversity in general and more stable predator-prey relationships. Statistically significantly, the group of robber flies benefits from extensive, organic farming and builds up stable predator populations in wheat. Wild bees benefit from the food supply of flower-rich weeds in organic wheat and appear in higher numbers of species and individuals.

At the end of the project, the results will allow statements about the influence of wheat cultivation systems of different intensity as well as fertilization methods and sowing methods on the abundance, diversity and function of predatory flies and their prey in the wheat cultivation systems. This predator-prey relationship is an indicator of the impact on functional biodiversity in wheat farming systems.

Eruca sativa accessions as resistance donors against pollen beetle (*Brassicogethes aeneus*) - metabolite profiling of secondary plant defence in green flower buds and genetic mapping in *E. sativa*

Paul, Rose Mary[1,2,3]; Böttcher, Christoph[2]; Austel, Nadine[2]; Meiners, Torsten[2]; Diederichsen, Elke[3]

[1]Institute of Plant Breeding, Christian Albrechts Universität, Kiel, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Ecological Chemistry, Plant Analysis and Stored Product Protection, Berlin, Germany.
[3]Applied Genetics, Genetics of plant resistance, Dahlem Centre of Plant Sciences, Freie Universität, Berlin, Germany.
Email of corresponding author: nadine.austel@julius-kuehn.de

Brassica napus is facing immense infestation by pesticide-resistant pollen beetles (*Brassicogethes aeneus*) and, given the large economic losses, resistance breeding to improve natural plant defense against insects is of great importance. Previous studies demonstrated that *Eruca sativa* is the least damaged by pollen beetles of many crucifers. Five *E. sativa* accessions were identified as resistance donors, and an introgression study was initiated. The aims of the presented study are A) support the identification of the phytochemical base of resistance in *E. sativa* and B) develop a genetic map of *E. sativa*, which will help to identify introgressed chromosomes from *E. sativa* in intergeneric hybrids with *B. napus*.

A non-targeted metabolomics approach using LC-ESI-TOF (liquid-chromatography-electrospray ionization-quadrupole-time-of-flight mass spectrometry) was conducted in *E. sativa* by extracting semi-polar compounds from green flower buds and analyzed in positive or negative ion mode. Selection of features for metabolite identification was conducted by correlating all features against feeding damage on buds. Certain features showed up quantitatively more often in some *E. sativa* accessions than in the standard *B. napus* cultivar ´Express´.

A genetic map of *E. sativa* will be developed using SSR (simple sequence repeat) markers. The PCR protocol to detect markers is established and polymorphic markers between two *E. sativa* accessions will be identified to be applied on a segregating mapping population. The F2 mapping population is derived from two accessions that show slight differences for their feeding damage. Using GISH (Genomic In Situ Hybridization) chromosomes from *E. sativa* will be visualized in backcross progenies of the intergeneric hybrids.

Metabolome profiling of *E. sativa* could reveal potential antifeedants such as glucosinolates or their hydrolysis products. The genetic mapping of *E. sativa* could support locating regions with resistance genes against pollen beetles on chromosomes in Brassicaceae. The combination of metabolites and genetic mapping will support the breeding of resistance against pollen beetles in *B. napus*.

Investigating the German hop virome

Pasha, Ali; Ziebell, Heiko

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Epidemiology and Pathogen Diagnostics, Braunschweig, Germany.
Email of corresponding author: ali.pasha@julius-kuehn.de

Germany has more than 20,600 hectares of hop-cultivated area and is the second biggest hop producer in the world. Many pests and pathogens threaten hop production. These can cause severe reduction in hop yield and quality.

In summer 2019, citrus bark cracking viroid (CBCVd) was detected for the first time in Germany. CBCVd is known as a pathogen of citrus plants that causes mild and often tolerated infections of different *Citrus* species, whereas it causes massive damages to hop plants.

The project "HopfenViroid" is addressing practical and scientific questions regarding CBCVd. As a part of this project, high-throughput sequencing (HTS) is being applied to investigate the viral diversity in German hop fields. In 2021, we have started with a pilot study, and 90 samples were collected from three fields in Hallertau (Southern Germany). The samples were collected from fields where CBCVd was detected previously. The samples from each field contained: 10 hop samples, 10 non-hop plants within the field, and 10 non-hop outside the field. Samples were pooled and double-stranded RNAs extracted as a viral and viroid enrichment approach (Gaafar and Ziebell 2020) followed by Illumina sequencing. Bioinformatic analysis was performed with Geneious Prime software (version 2022.1.1). Raw reads were normalized and *de novo* assembled. Assembled contigs were mapped to a local database of virus and viroid sequences downloaded from NCBI. All identified viruses and viroids in hops across the three fields were previously described as hop pathogens. In 2022, this study has been extended to cover three different hop-growing locations in Germany. A comprehensive understanding of the viral diversity in German hops is expected by the end of this study.

Effect of elevated CO_2 concentrations on morphological traits of different winter wheat varieties

Kretschmer, Lars; Greef, Jörg-Michael; Kottmann, Lorenz

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
Email of corresponding author: lars.kretschmer@julius-kuehn.de

Global concentrations of CO_2 are projected to increase to 650 ppm (RCP4.5) by the end of the 21st century. Considering this steadily increasing CO_2 concentration since the industrial revolution and the associated climate changes, it becomes more and more relevant how wheat and its pathogens cope with these future climate conditions. As winter wheat (*Triticum aestivum* L.*)* is one of the most important crops in terms of human nutrition, it is particularly important to maintain its productivity. Elevated CO_2 concentrations have the potential to increase yields and to buffer the negative effects of climate change like drought and heat stress.

At Institute PB we are investigating the response of different winter wheat cultivars to elevated CO_2 concentrations (e[CO_2]) within the project WheatFACE[1]. Using a free air carbon dioxide enrichment (FACE) facility, we adjust the CO_2 concentration to 600 ppm in our experimental plots and compare them to plots with ambient CO_2 (a[CO_2]) concentrations. We are investigating the influence of e[CO_2] on the development, physiology, and agronomic characteristics of the wheat varieties. Special attention is paid to plant traits that influence the infestation of leaf rust (*Puccinia triticina)* and fusarium (*Fusarium graminearum*), such as stomata number and density, stomatal conductance or leaf area.

In 2022, we conducted a preliminary FACE-trial with 12 genotypes. We investigated traits such as the phenological development (BBCH), leaf area, leaf area index (LAI), and stomatal conductance. Furthermore, we conducted a partial harvest at mid flowering (BBCH 65) and complete harvest at maturity (BBCH 89) to determine agronomic data such as grain yield and aboveground biomass. We got the first promising results, such as a significant CO_2 fertilization effect, changes in the stomatal conductivity and changes in leaf area compared to the control group.

In 2023 and 2024, we will perform further field trials with the FACE-facility which will also feature the inoculation of plots with leaf rust and fusarium. We want to address the question if the adaption to e[CO_2] lead to changes in quality and yield of the wheat varieties and which of these adaptations may alter the infestation with leaf rust or fusarium.

[1] Phenotypic and genetic determinants for adaptation of winter wheat to increasing CO_2 concentrations using leaf rust and ear fusarium resistance as examples.

Fungal pathogens of St. John's wort and anise

Kreth, Lana-Sophie; Götz, Monika

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Urban Green, Braunschweig, Germany.
Email of corresponding author: lana-sophie.kreth@julius-kuehn.de

Despite rising demand, medicinal plant cultivation in Germany has been stagnating for years. The increasing demand is currently covered to approx. 85-90 % by imports. To promote German medicinal plant cultivation and to ensure product quality, the Junior Research Group Medicinal Plants was established at the Julius Kühn Institut. In the main topic "seed-borne and leaf pathogens", the focus is on the investigation of fungal pathogens, especially on St. John's wort (*Hypericum perforatum*) and anise (*Pimpinella anisum*), and the development of alternative strategies for their control. Over a period of three years (2020-2022), the currently occurring fungal pathogens in Germany (and Austria) were investigated in an extensive screening. For this screening, a total of 41 seed batches and 35 plant samples of St. John's wort and anise were examined. 654 fungi were isolated and 320 of them were characterized morphologically and by DNA barcoding. 61 isolates were included in the institute's strain collection. The St. John's wilt pathogen is a severe problem on *H. perforatum*. In the course of the project, the pathogen was taxonomically reassigned. In addition, a rapid and sensitive detection method using real-time PCR was established and verified for this pathogen. This is now available for routine testing of *Hypericum* seed and plants.

In anise different fungal pathogens led to serious infections. These are currently being investigated in more detail.

Phenotypic and genetic determinants of winter wheat adaptation to increasing CO_2 concentrations using ear fusarium as an example

Waßmann, Lisa; Rodemann, Bernd

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Braunschweig, Germany.
Email of corresponding author: lisa.wassmann@julius-kuehn.de

Since the beginning of industrialization, the concentration of CO_2 in the atmosphere has steadily increased to currently 410ppm and a further increase is to be expected. On wheat, elevated atmospheric CO_2 concentrations (eCO_2) have positive effects through stimulation of photosynthesis and a resulting increase in above-ground biomass. However, this offers a larger potential attack surface for pathogens.

Fusarium graminearum and *Fusarium culmorum* cause fusarium head blight in wheat, and in addition to yield losses, infection with these fungi can lead to the formation of mycotoxins that pose a health hazard to humans and animals. At eCO_2, increased levels of the mycotoxin deoxynivalenol and more severe symptom expression has already been measured in some wheat varieties after inoculation with *Fusarium culmorum*. However, only a small set of wheat cultivars has been tested so far, so that there is a need for clarification of the eCO_2 influence on ear infestation and toxin contamination, especially in the case of quantitative differences in *Fusarium* infestation.

In this part of the WheatFACE project, new insights into the influence of eCO_2 on the pathogenicity and virulence of *Fusarium graminearum* will be investigated in different winter wheat varieties.

In vitro laboratory studies will test the influence of eCO_2 on the biology of *Fusarium graminearum*. For this purpose, mycelial growth, spores and toxin formation of different isolates will be investigated at different CO_2 concentrations. In greenhouse experiments, a set of more than 200 winter wheat genotypes will be examined with regard to their infestation with *Fusarium graminearum* at different CO_2 concentrations. A selection of divergent genotypes will be tested in the Free Air Carbon dioxide Enrichment (FACE) facility under field conditions.

To assess disease infestation, the infestation frequency and severity will be recorded and the *Fusarium* head blight index will be calculated. Furthermore, the number of *Fusarium*-damaged kernels and presence of *Fusarium*-DNA in the grain will be determined and toxin analyses will be performed.

Quality improvement in vegetable production through robot-assisted slug control

Puliga, Giovanni Antonio; von Hörsten, Dieter; Wegener, Jens Karl

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Application Techniques in Plant Protection, Braunschweig, Germany.
Email of corresponding author: giovanni.puliga@julius-kuehn.de

In Europe, several slug species are important pests in agricultural and horticultural crops. Damage is caused by slugs due to feeding activity and contamination with faeces or slime, leading to deterioration in the quality of the products and financial loss. In horticultural crops, this damage may occur from seedling or transplanting until harvesting, and therefore, control measures need to be applied during the whole growing season.

Traditionally, the most common method for slug control is the spreading of slug pellets containing either metaldehyde or iron-III-phosphate as a molluscicide. However, the application of such baits may be harmful for beneficial organisms and its success is highly dependent on the timing of application and weather conditions. Other preventive methods available to farmers to contrast slugs are represented by soil management practices such as tillage and fine seedbed preparation. The only alternative to chemical and preventive methods remains the manual collection of slugs in the field, which implies a huge workload, and it is therefore feasible only in limited areas.

The aim of this research project is to develop a robot-assisted solution to control slugs in horticultural crops, in order to provide this sector with a valid alternative to the manual slug collection, meanwhile reducing the use of chemical substances.

The planned robot will be able to monitor the vegetable field, detect the slugs and eliminate them using physical methods. For its construction, various technical solutions, some of which already exist from a previous project (MSR-Bot), will be adapted, further developed and combined together. The robot, which is battery powered, will be navigating autonomously in the field, and it will be equipped with an arm, with a camera to detect slugs and a tool to control them at its end.

Salad crops have been chosen to test the whole system. The control of slugs on these plants is particularly challenging, because the threshold for slug damage is very low during the whole growing season and slugs can be found on the ground as well as on the adult plants. Therefore, the control tool should be able to eliminate them without damaging the plant and the final product. Other important criteria for the selection of the control method are energy efficiency and technical feasibility.

Based on these considerations, physical control methods are being investigated. In particular, picking up slugs from plants with suction and eliminating them using electricity. Collecting the slugs would have the advantage, compared to the electric solution, that the pests could be also removed from the plants. A contamination by slug's bodies would not occur in this case. Efficacy and feasibility of both methods are currently being tested in the context of laboratory experiments.

Trapping the digger wasp *Pemphredon lethifer* (Sphecidae) with trap nests

Furtwengler, Jana; Böckmann, Elias

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Urban Green, Braunschweig, Germany.
Email of corresponding author: jana.furtwengler@julius-kuehn.de

Twig nesting digger wasps of the genus *Pemphredon* use aphids as food for their brood. The wasps transport the aphids to their nests which they dig into twigs. They could therefore be relevant as beneficial organisms for aphid control. In particular, the species *Pemphredon lethifer* (Shuckard 1837) is of interest here, as it is widespread and has low habitat demands. To start continuous rearing systems of *P. lethifer*, a large quantity of individuals is required. The aim of this study is to examine trapping systems to trap *P. lethifer* individuals. Trap nests have been widely used to trap wasps of the genus *Pemphredon* for monitoring purpose. However, there is no information about mass trapping of *P. lethifer* for rearing purposes. To approach an optimized trapping system, the parameters such as duration of nesting process and the resulting optimal sampling intervals are investigated.

In the year 2022, at each of 28 study sites in Braunschweig and the surrounding area three trap nests were installed in May. The study sites were chosen based on the preferred nesting plants of *P. lethifer Sambucus spp.* and *Rubus spp.*. The trap nests consist of 16 30 cm long twigs of *Sambucus*. The twigs were tied together with wire. Trap nests were hung into *Sambucus* or *Rubus* branches and were oriented east-to-west. The nests were checked weekly for signs of nesting. As soon as signs of nesting were visible, the twig was marked with a dot. Twigs with signs of nesting were removed a) one week after the first sighting (1 dot) or b) two weeks after the first sighting (2 dots). Removed twigs were replaced by new ones. Nests were reared in the laboratory by 25° C. Adult wasps, which were present in the nests, were collected and identified. All emerged wasps and parasitoids were counted and determined.

Nesting activity in the field was from May until the End of August with peaks at the beginning and the end of June. Preliminary results of this year's investigation show, that the number of digger wasps emerged from trap nests left in the field for two weeks was higher than for nests left in the field for only one week. Hence, we conclude based on the current findings, that *P. lethifer* usually needs an interval longer than one week to complete the nesting process. To establish a rearing system, nests of *P. lethifer* should stay in the field for at least two weeks to maximize the number of emerging wasps.

The preliminary results only consider wasps that emerged without diapause. In order to draw a final conclusion, wasps with an obligatory diapause must also be considered. To initiate diapause twigs are chilled.

The findings are crucial for establishing a successful rearing of digger wasps to use them as beneficial organism in high quality horticultural crops.

Investigation of ToBRFV as part of the VIRTIGATION project

Rohde, Mareike J.; Ziebell, Heiko

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Epidemiology and Pathogen Diagnostics, Braunschweig, Germany.
Email of corresponding author: mareike.rohde@julius-kuehn.de

Curcubitacea and tomatoes are among the most important food crops in the EU and worldwide. In the year 2020 tomatoes were the leading vegetable crop worldwide with a production volume of 187 million metric tons. Cucumber, eggplant and pepper were among the top ten of this list. This highlights the importance of a sustainable production for these cultures.

The EU project VIRTIGATON deals with emerging viral diseases in tomatoes and curcubits and aims to implement mitigation strategies for durable disease management. One of the main focus areas of this project is the tomato brown rugose fruit virus (ToBRFV). It was first encountered in 2014 and described as a new virus species in 2016. Since then it has spread in Europe, Asia and America and is currently present in 34 countries, according to the EPPO database. It can overcome the $Tm2^2$ resistance, which is commonly used in commercial tomato cultivars. It confers resistance against tobamo viruses, such as the tobacco mosaic virus.

ToBRFV has the potential to cause relevant economic losses to tomato growers worldwide.

To gain a better understanding of the virus and its pathogeny factors, an infectious clone is being developed at the JKI. To that end, the full length viral genome has been cloned in a binary vector using Gibson assembly. The viability of this method has been demonstrated by Ma et al. in 2021 with a ToBRFV isolate from Yunnan. Here, an Israeli and a German isolate will be used.

Mutations will be induced in the viral genome and a screening for attenuated strains will be conducted.

These will be useful tools for a better understanding of the impact of sequence variation in different virus strains and to study virus host interaction.

Mapping for *Wheat dwarf virus* (WDV) resistance in wheat (*Triticum aestivum*)

Pfrieme, Anne- Kathrin; Will, Torsten; Serfling, Albrecht; Stahl, Andreas

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
Email of corresponding author: anne-kathrin.pfrieme@julius-kuehn.de

Wheat dwarf virus (WDV) is an important pathogen in wheat and other cereals. In many European countries, e.g. Hungary, Spain and Germany, WDV causes high yield losses. WDV is transmitted by the leafhopper *Psammotettix alienus*. Symptoms of WDV infection in wheat include chlorosis, dwarfing and streaking, and high yield losses. The economic importance of insect-borne viruses will increase in the coming years with climate change and the associated greater global vector activity. Control of leafhoppers with insecticides is limited. Legal regulations and measures for environmentally and consumer friendly crop production further limit their use. However, little is known about the sources of WDV resistance.

A previous project screened wheat accessions for WDV resistance/tolerance and used genome-wide association studies (GWAS) to identify quantitative trait loci (QTL) involved in the expression of WDV tolerance. The aim of the present project was to make these sources of tolerance useful for wheat breeding. For this purpose, breeding partners produced biparental populations by crossing the tolerant accession 'Fisht' with susceptible cultivars. This material was phenotyped for WDV tolerance in field and greenhouse trials and genotyped with a 25k Illumina Infinium chip. Based on these data, QTL for WDV resistance were mapped.

The identified QTL for WDV resistance will enable the development of molecular markers essential to replace the tedious and time-consuming resistance testing with WDV-bearing locusts. This will facilitate the integration of breeding for WDV resistance/tolerance into applied wheat breeding.

Impact of soil and weather conditions on yield and quality of different *Lolium perenne* varieties

Shi, Yuhong[1]; Wrage-Mönnig, Nicole[1]; Gabriel, Doreen[2]; Kuka, Katrin[2]

[1]Chair of Grassland and Fodder Sciences, University Rostock, Rostock, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
Email of corresponding author: yuhong.shi@julius-kuehn.de

Perennial ryegrass (*Lolium perenne*) is a very valuable and globally widespread forage grass. The yield and quality characteristics of *L. perenne* depend on its growth conditions, such as soil and weather conditions. The objective of this study is to determine which soil- or weather parameters can best explain the yield and nutritive values and how they interact with different *L. perenne* varieties.

From 2017 to 2019, field trials were carried out at 14 locations with 10 *L. perenne* varieties in cooperation with breeders and state institutes, as well as the Federal Plant Variety Office. In addition to yield data, the quality parameters (e.g. crude protein, crude fibre, WSC etc.) of all plant samples were determined by NIRS measurement. We present here the data of the first cut of 2017. Mixed effects model was applied to analyze the influences of soil and weather conditions on yield and various quality characteristics of *L. perenne*. The results showed significant influences of average temperature (T), accumulated precipitation of the growth period (NS), and field index on dry matter yield (DM). The DM increased linearly with T, while it showed an optimum curve with NS. Strong relationships of T and NS with nutritive values were also found for crude protein (CP), crude fibre (CF), and water soluble carbohydrates (WSC). However, they were also affected by further parameters, such as P_2O_5 content, field index, and humus level in soil. The next steps will be the statistical analysis and interpretation of the complete data set.

Innovative methods for controlling the fungus gnat using beneficial species

Kalweit, Lars; Kühne, Stefan

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
Email of corresponding author: lars.kalweit@julius-kuehn.de

Fungus gnats (Sciaridae) are among the most important pests in greenhouse cultivation and can lead to considerable crop losses. They are a significant problem especially in organic cultivation of potted plants, particularly potted herbs, since peat-reduced, organically fertilized growing media are much more attractive to fungus gnats and provide them with much better living conditions. Previous methods to reduce the mass reproduction of fungus gnats in organic farming have proven insufficient. The development of innovative biological methods using beneficial species is a cornerstone for the future of organic agriculture.

The studies in this project aim to evaluate the efficacy of the fungus gnat antagonists *Steinernema feltiae* and *Hypoaspis miles*, which are well established in practice, and to optimize their use through new research. Another aspect is to investigate the efficacy of new beneficial species from the orders Geophilomorpha and Lithobiomorpha and the genera *Coenosia* and *Atheta*. To achieve the objectives, two basic research approaches were chosen: Laboratory experiments and field experiments.

In the first phase of the project, laboratory experiments were conducted in climate chambers at Julius Kuehn-Institute in Kleinmachnow. The beneficial insect species *Steinernema feltiae* and *Hypoaspis miles* were tested for their efficacy against *Bradysia difformis* larvae. In addition, it was investigated whether a higher efficacy could be achieved by combining *Steinernema feltiae* and *Hypoaspis miles*. Preliminary results showed that both beneficial species resulted in a significant reduction in the hatching rate of *Bradysia diffomis*. Treatment with *Steinernema feltia* reduced the hatching rate by 70%, while treatment with *Hypoaspis miles* reduced it by 65%. The combination of the two beneficial species almost eliminated the larvae. Only isolated larvae hatched. Extensive synergistic effects of the beneficial species need to be investigated in further trials.

In the second phase, field trials were conducted in the Hirschgarten greenhouse. The aim was to evaluate the interactions between fungus gnats and the *Coenosia* population. *Coenosia spec*. is considered a promising fungus gnat antagonist. Yellow pan traps and counts of single individuals were conducted at weekly intervals. Preliminary results from 2022 indicate a decrease in fungus gnats that correlates with an increase in the *Coenosia population*. The results will be validated by repeating the monitoring next year.

In a further experimental phase, non-established beneficial species of the orders Geophilomorpha and Lithobiomorpha (centipedes) as well as of the genus *Atheta* will be included in the trials. In addition to basic questions on breeding, feeding behavior and prey spectrum, commercial implementation will also be investigated.

Wheat undersowing for pest regulation in white cabbage

Köneke, Anna; Böckmann, Elias

Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Urban Green, Braunschweig, Germany.
Email of corresponding author: anna.koeneke@julius-kuehn.de

Intercropping is a broadly studied measure for biological control in vegetable crops. Although many studies already confirmed pest regulating effects of different cabbage intercropping systems, especially undersowing with clover species, the system is still not widely transferred into agricultural practice. Therefore, we evaluated the overall suitability of winter wheat as undersowing plant for white cabbage, as it is easy to assess and establish for farmers and unlike clover does not develop offshoots. Pest regulating effects with focus on flea beetles and aphids, as well as effects on yield and natural enemy abundance were assessed.

Between the years 2017 and 2021, six field trials were conducted in small plots (20-32 m2), each in randomized complete block design in four to eight repetitions. In each trial, undersown cabbage plots were compared to control plots without undersowing. In undersowing plots, single-rows of wheat were sown directly between cabbage rows. Wheat was sown six weeks before transplanting of cabbage in middle of May, to ensure effects on pest insects in early cabbage developmental stages. Numbers of flea beetles and their feeding damage as well as numbers of aphids and their natural enemies were counted weekly on six to ten cabbage plants per plot. In four of the six trials, epigeic predators such as spiders, rove beetles, coccinellids and ground beetles were additionally assessed in pitfall traps. In October, harvested cabbage plants were weighed and remaining quality losses due to feeding of pest insects were assessed on harvested heads and roots.

Results show reduced numbers of Phyllotreta spp. flea beetles and both aphid species, Brevicoryne brassicae and Myzus persicae in undersown cabbage in most of the years. However, enhancing effects on natural enemies are not consistent in all trials. Also, there was a slight but significant negative effect on yield in some years.

Tolerance spectrum of barley powdery mildew and its influenceability by bioprotectants and drought stress – Insights into the project MORGEN

Hamburger, Susanne[1]; Enders, Leon[1]; Wehner, Gwendolin[2], Matros, Andrea[2]; Töpfer, Veronic[2]; Feike, Til[3]; Meziane, Asmae[3]; Schmitt, Annegret[1]; Linkies, Ada[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Biological Control, Dossenheim, Germany.
[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Resistance Research and Stress Tolerance, Quedlinburg, Germany.
[3]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
Email of corresponding author: susanne.hamburger@julius-kuehn.de

Crops worldwide are threatened by drought and infectious diseases. As a result of climate change, periods of heat and drought will increase and might enhance yield losses due to increased abiotic stress and higher damage by pathogens. Barley cultivation, that has thousands of years of history, is increasingly coming under pressure. Further, the use of chemical-synthetic fungicides is increasingly questioned due to its negative effects on the environment. Therefore, there is a high demand for sustainable products, such as plant extracts and microorganisms. These products can have a direct antagonistic activity or function indirectly by promoting plant growth and resistance. The aim of the project MORGEN is to protect barley in a sustainable way from the challenges of climate change and the associated increased occurrence of powdery mildew (*Blumeria graminis*). In a first step, a routine method for airborne inoculation of potted barley plants with defined doses of conidia and reproducible infection results for comparative analyses could be established at the JKI Institute for Biological Control. By applying the method, a set of 50 barley accessions was analysed and accessions with high resistance to powdery mildew were successfully identified and significantly differentiated from those with medium or low resistance. In the next step the preventive effect of 18 plant strenghener/plant protection products/biostimulants (plant extracts and microorganisms) on powdery mildew infection was determined using selected genotypes of different susceptibility. The influence of drought stress on plant development and on the efficacy of some of the products examined was also investigated. Two potent preparations (plant extract/animal product) against barley powdery mildew were identified, whose excellent protective effect was independent of drought stress in our experiments.

The presentation (i) shows a simple, cost-effective and statistically validated inoculation method for powdery mildew in barley, which might also be applicable/extendable to other crops, (ii) extends the knowledge on powdery mildew resistance in different barley lines and (iii) presents alternative control agents with a high efficacy against powdery mildew, which can contribute to more sustainable crop production.

Transgenerational effects of heat and drought stress in oilseed rape (*Brassica napus L.*)

Sabboura, Dima[1,4]; Kandhimalla, Rohith Reddy[1]; El Habbasha, El Sayed[2]; Gabriel, Doreen[3]; Kautz, Timo[4]; Brunel-Muguet, Sophie[5]; Feike, Til[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.
[2]Field Crops Research Department, National Research Center, Egypt.
[3]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.
[4]Department of Crop Science, Humboldt Universität zu Berlin, Germany.
[5]French National Institute for Agriculture, Food, and Environment (INRAE), France.
Email of corresponding author: dima.sabboura@julius-kuehn.de

Oilseed rape (*Brassica napus L.*) is a major global oil crop grown mainly under temperate climatic conditions. With increasing global edible oil demand and improving genetic yield, its production further expands to warmer climatic zones. Additionally, climate change leads to increasing heat and drought stress, which are limiting factors to plant growth, development, and productivity, which lead to impeding agronomic and economic performance, and seeds germination, as a primary stage of plant development, can be affected strongly by the abiotic stress that occurs during mother plant growth and development. A pot experiment was conducted in the experimental facilities at Julius Kühn Institute in Kleinmachnow. The study investigates the single and combined effects of heat and drought stress on crop morphology, physiology, and yield formation under the timing and intensity of stress. Hence, four factors are tested in combination: heat stress at four levels and drought stress, treatment timing, and treatment duration with two groups each. Harvested seeds were planted on Petri dishes under controlled conditions in climate chambers, under 23°C; seeds were irrigated at the beginning of the experiment. Germinated seeds were accounted for every 2 hours from 12 hours of planting until 40 hours after planting.

We find that all experiment factors excerpted significant effects on germinated percent, with increasing heat and drought stress as well as longer duration leading to changes in germination rate. We further find that seeds showed more response under drought stress. We find that both heat and drought affected germination at different branch levels.

Identification of phytopathogenic fungi and oomycetes from peat substitute substrates

Soliz Santander, Fabricio Fabián; Riebesehl, Janett

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Horticulture and Urban Green, Braunschweig, Germany.
Email of corresponding author: fabian.soliz@julius-kuehn.de

In the current global concern about climate change, the protection of peatlands is becoming increasingly important, leading to a reduction in the use of peat in substrates for horticulture.

As part of the project "Development and evaluation of peat-reduced production systems in horticulture (ToPGa)", mycological influences associated with peat-reduced culture media are being investigated, with a major focus on preloading fungi and oomycetes on peat substitutes, of which potential plant pathogens are important.

In this research work, the use of fiber nettle (*Urtica dioica* L. convar. *fibra*) as well as digestate (fermentation residue) from biogas generator plants as possible components of peat substitutes is investigated. The possible pre-contamination of the substrate components with fungi and oomycetes is considered in order to classify the isolated species according to their lifestyle and consequently to identify possible phytopathogenic species.

Sample material from digestate and fiber nettle was first prepared for isolation of microorganisms.

For the isolation of fungi, two main methods were used: first, isolation via dilution series (Waksman, 1922) and second, by directly placing material on nutrient media (Warcup, 1950). For the isolation of oomycetes, a bait test with rhododendron leaves was used (Junker et al. 2018). All three methods aim to culture living fungi and oomycetes found in the samples.

After isolation, DNA was extracted from the cultures and PCR of the ITS region was performed. Subsequently, the PCR products were purified and sequenced.

Microorganisms were identified by comparing their sequences (BLAST) with those in NCBI GenBank and by morphological determination of the cultures.

The partial results of the current work show a collection of 144 fungal isolates from the digestate and fiber nettle samples. These isolates were successfully identified at the genus level. To date, no oomycetes have been isolated from the samples.

Processing is ongoing and new samples are currently being processed and additional organisms isolated.

After identification at the species level, classification by lifestyle and thus determination of plant pathogens will proceed.

Calibration of soil erosion models for perma-nent bioenergy crops

Koch, Tobias[1,2]; Deumlich, Detlef[2]; Chifflard, Peter[3]; Panten, Kerstin[1]

[1]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Crop and Soil Science, Braunschweig, Germany.

[2]Zentrum für Agrarlandschaftsforschung (ZALF) e.V., Müncheberg, Germany.

[3]Philipps-Universität Marburg, AG Soil and Water Ecosystems (SWEco), Marburg, Germany.

Email of corresponding author: tobias.koch@julius-kuehn.de

Agricultural management systems are in transition amongst others through the promotion of renewable energy by legislations such as the renewable energy law (EEG) in Germany or the EU Green Deal. Biomass production as renewable energy source has been increased continuously. So far, maize is mostly used as feedstock in e.g. biogas plants. However, the production of maize as an energy crop has led to criticism due to an increased risk of water erosion and associated water body eutrophication. This problem is further aggravated through the increase in precipitation extremes due to climate change. Alternative strategies for biogas crop production are strongly required with permanent crops being of particular interest. Well-calibrated models are essential to make proficient statements about the erosion reduction potential of alternative biogas crops on erosion prone sites in order to support planting and political decisions. To calibrate soil erosion models, it is necessary to parameterise the underlying model equations. Monitoring and quantifying water erosion of soil is labour and time consuming and therefore rarely conducted. A case study is presented that addresses the quantification of soil erosion under commercial conditions and thus gains experimental data to calibrate and validate soil erosion models for permanent bioenergy crops. The study starting in 2021 is conducted in the Elm low mountain region near Braunschweig and on the Pfullendorfer young moraine landscapes near Sigmaringen. It compares in a randomized block design with three replicates conventional maize cultivation, direct seeding management of maize, and the permanent plant Silphium perfoliatum L. Preliminary data obtained during the year of experimental establishment (2021) demonstrated that the experimental design of the runoff plots will allow the calibration of the physically based model Erosion 3D. First erosive natural rainfall events with EI_{30} intensities ranging from 8 N/h up to 73 N/h. Additionally, artificial precipitation extremes will be simulated if necessary in 2022 and 2023. It is expected that increasing positive effects of the permanent crop will be seen with each additional year.

Dealing with model errors while calibrating crop models: A Bayesian perspective

Viswanathan, Michelle[1;2]; Weber, Tobias K.D.[1]; Streck, Thilo[1]

[1]University of Hohenheim, Institute of Soil Science and Land Evaluation, Biogephysics, Stuttgart, Germany.

[2]Julius Kühn Institute (JKI) – Federal Research Centre for Cultivated Plants, Institute for Strategies and Technology Assessment, Kleinmachnow, Germany.

Email of corresponding author: michelle.viswanathan@julius-kuehn.de

Process-based crop models are a mathematical representation of our knowledge about biophysical processes that describe plant growth and interactions with the environment. These models serve as useful tools for predicting the impact of climate change on crop production or assessing the fate of agrochemicals in the environment. To ensure robust predictions, models are usually calibrated to observations. While uncertainties in observations are usually taken into account, other sources of uncertainty such as those in model inputs, equations, parameters, etc. also need to be quantified. This is especially important when model predictions guide adaptation and mitigation strategies. Bayesian inference is suitable for this purpose since it enables the accounting of different uncertainties, while also incorporating prior knowledge. Thus, Bayesian methods are used for model calibration to improve system-representation and therefore enhance prediction quality. However, this does not always occur due to the presence of model errors. These errors are a result of incomplete knowledge or simplifying assumptions made to reduce model complexity and computational costs. We investigated the problems in calibrating such imperfect crop models using Bayesian inference with commonly used simple statistical assumptions about errors. Then, we tested two other Bayesian approaches that could address these problems.

We first tested the commonly applied simple Bayesian approach to calibrate a process-based phenology model to observations of silage maize. In this approach, model parameters and their uncertainty were estimated while accounting for observation uncertainty, but ignoring model errors. We found that as the model was calibrated to increasing amounts of observation data, the uncertainty in the model parameters reduced as expected. However, the prediction quality of the calibrated model did not always improve. This was attributed to the presence of model errors that was ignored during calibration. As a potential solution, we calibrated the model using Bayesian multi-level modelling (BMM) which could account for model errors. Furthermore, we also accounted for the hierarchical structure of cultivars nested within maize ripening groups, thus simultaneously obtaining model parameter estimates for the species, ripening groups and cultivars. Applying this approach improved the model's calibration quality and further aided in identifying possible model deficits related to temperature effects in the post-flowering phase of development and soil moisture. As a second potential solution, an alternative calibration strategy was tested which accounted for model errors by relaxing the strict statistical assumptions in classical Bayesian inference. This approach resulted in conservative but more reliable predictions than the commonly used approach, except when the prediction target represented an average behaviour of all calibration data.

Our results showed that Bayesian methods with representative error assumptions led to improved model performance and a more realistic quantification of uncertainties. This could facilitate the effective application of process-based crop models in predictions.

Julius Kühn-Institut
Bundesforschungsinstitut für Kulturpflanzen