

Master- and Bachelor Thesis Topics 2019-2020

Master- /bachelor-oppgaver

Plant protection

Plantevern

Her er mange forslag til spennende oppgaver innen plantevern, d.v.s. ugras/herbologi, plantepatologi, landbruksentomologi og pesticidkjemi. Dersom du vil finne ut mer om oppgavene ta kontakt med veilederen(e) som er oppført, med kopi til faggruppelideren i Plantevern og Matplanter siv.remberg@nmbu.no. Du kan også komme med eget forslag til oppgaver.

Below you will find many interesting thesis topics in plant protection, including weed science, plant pathology, agricultural entomology and pesticide science. If you want to know more about a topic, contact the supervisor listed for the topic, and copy to the head of section siv.remberg@nmbu.no. You can also suggest a topic that is not listed here.

Plant pathology

Plantepatologi

11	Production of virus-free Norwegian old potato cultivars

Background

Potato (*Solanum tuberosum* L.) is globally the fourth largest staple crop after rice, wheat and maize. Viral diseases have been a limiting factor for sustainable production of potato. About 40 viral species have been reported to infect potato worldwide. Use of virus-free seed tubers is an effective, practical means of controlling potato viruses.

Norway has a wide diversity of potato varieties from Norwegian breeding and international importation, while there are another big amount of old cultivars, which have been preserved by generations of farmers and hobby growers. All of these old Norwegian potato cultivars are heavily infected with different viruses, especially *Potato virus X* (PVX) and *Potato virus S* (PVS), which are the most difficult to eliminate.



Figure 1 Norwegian old potato cultivars and virus symptoms on indicator plants

Thesis

The master thesis will include 1) potato virus detection with plant indicators, ELISA and RT-PCR; 2) elimination of PVX and PVS from Norwegian old potato cultivars with different methods; 3) histological study of PVX and PVS infection in potatoes and their interactions.

Supervisors

Dag-Ragnar Blystad (NIBIO) dag-ragnar.blystad@nibio.no

Zhibo Zhang (NIBIO) zhibo.zhang@nibio.no

12	Diagnosis and elimination of viruses infecting Norwegian shallot onions

Background

Shallot, a genus of *Allium*, has a high economical potential for the Norwegian agriculture, while the production is limited due to heavy virus infection. The notable viruses are *Potyvirus* (*Onion yellow dwarf virus*, OYDV), *Carlavirus* (*Shallot latent virus*, SLV) and *Allexivirus* (*Shallot virus X*, ShVX). It is indispensable to establish effective and precise diagnosis tools in Norway. In addition, production of virus-free and healthy shallot mother stocks is essential for efficient commercial production.



Figure 1 Norwegian shallots infected with different viruses

Thesis

The master thesis will include 1) shallot related viruses diagnosis with host plant indicators, serological methods such as ELISA, and RT-PCR; 2) establishment of tissue culture of shallots; 3) elimination of shallot related viruses from Norwegian shallots with meristem culture, thermotherapy, chemotherapy, et al., in order to obtain virus-free shallot seed plants for further production.

Supervisors

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13	Vector based virus elimination
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Vector based virus elimination

In general, getting rid of a virus from an infected plant (i.e. making the plant virus-free) is a challenging and laborious task. The only currently known methods are meristem tip *in-vitro* culture in combination with temperature treatments. These methods are costly since they require special facilities, equipment, dedicated personnel and are time consuming. RNAi, also known as RNA silencing, is a mechanism by which transcription or translation of a gene is suppressed in a sequence specific manner. RNAi is triggered by double stranded RNA (dsRNA) molecules which are subsequently recognized and cleaved by the host-encoded RNase III like-enzyme “Dicer” or its homolog into small interfering RNA (siRNA), or a related type of small RNA referred to as microRNA (miRNA), of 21–25 nucleotides in length. These siRNAs (or miRNAs), in conjunction with the RNA induced silencing complex, target RNA molecules with homologous sequences (endogenous or exogenous like viruses) for sequence-specific degradation or inhibition of translation. RNAi has been identified as an important mechanism of gene regulation in multicellular eukaryotes and also as an important antiviral defence in plants and invertebrates. Efficient resistance to virus infection has been achieved by genetically transforming plants to trigger RNAi-based resistance to viruses. However, this study will not use RNAi as a method to generate resistance to the virus, but rather to eliminate the virus from an infected plant.

The student will gain competence in the following areas and techniques: Molecular biology, virology, gene technology, recombinant DNA techniques, plant genetics and plant pathology.

Contact: carl.spetz@nibio.no

14	Dissecting viral replication mechanisms
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Replication of all positive-sense single-stranded RNA viruses occurs in specific structures in close association with cellular membranes. Targeting of the viral replication complex (RC) to the site of replication is mediated by the interaction of viral-encoded proteins and host factors. Electron microscope studies have shown that *Poinsettia mosaic virus* (PnMV, family *Tymoviridae*) infection is associated with the presence of vesicular structures in the chloroplasts, which indicates that the replication of PnMV might occur in association with chloroplast-derived membranes. Using computer assisted homology search, we have identified that the coat protein (CP) of PnMV shows similarity to membrane bound proteins and contains a conserved amino acid sequence motif found in members the Alb3/Oxa1/YidC protein family. This protein family is involved in the insertion of proteins into intracellular membranes. We hypothesize that the targeting of the PnMV RC to the chloroplast is mediated by viral-encoded CP. We plan to test this hypothesis carrying out co-localization studies using transient and stable expression of GFP-tagged viral proteins and confocal laser scanning microscopy.

The student will gain competence in the following areas and techniques: Molecular biology, virology, gene technology, recombinant DNA techniques, plant genetics and plant pathology.

Contact: carl.spetz@nibio.no

15	Defense priming against pathogen attack / epigenetic regulation of pathogen resistance in plants
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Goal: Each year 30-40 % of global crop production is lost to pathogens like fungi, bacteria, insects, nematodes and oomycetes, and is thus a major threat to the farmer's economy and global food security. Treatment of plants with hormones or other elicitors may enable plants to become more resistant to pathogen infection or insect attack several weeks after treatment. This effect is called defense priming and mediates a faster and/or stronger induction of defenses to subsequent challenges. We want to identify the epigenetic mechanisms that are involved in this priming effect to improve crop yield and reduce the use of pesticides.

Background: Developmental transitions or environmental stimuli like heat, drought or pathogen attack, can lead to heritable but reversible changes in gene expression and phenotype without changes in the underlying DNA sequence. This is called epigenetic gene regulation, and is mediated by specific enzymes that alter DNA or the associated histones with different chemical modifications. Recently several studies have shown that these enzymes are important for defense against pathogen and herbivore attack in plants. However, their role in defense priming and climate adaption in strawberry is unknown.

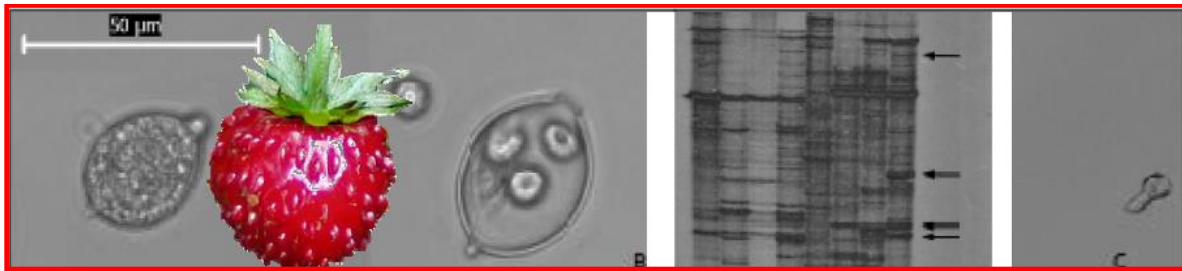
The project: We have created several lines of wild strawberry (*Fragaria vesca*) that are mutant for important epigenetic modifiers using the gene editing technology CRISPR/CAS9. These lines will be primed for pathogen defense using different chemical elicitors or biological priming agents to induce the plant immune system. Subsequently the plants will be challenged with different pathogens including fungi, oomycetes and bacteria, and then scored for resistance to determine if the mutant lines are more or less resistant against pathogen attack compared to wild type. After phenotypic scoring, candidate defense genes will be analyzed by RT-qPCR to identify if they are epigenetically regulated and involved in the observed phenotype.

Researchers in plant pathology and molecular biology will supervise the master student during the project, and we have a collaboration with researchers at the University of Oslo that will be involved in the supervising. The master thesis will be part of the Toppforsk-project "Beyond the genome: epigenetics of defense priming and climatic adaptation in plants" funded by the Research Council of Norway and NIBIO.

You will learn: Standard molecular techniques such as cloning, PCR, real-time qPCR as well as plant and pathogen specific techniques, and CRISPR/Cas9 gene editing.

For further information: Tage Thorstensen, phone: 40200909, e.mail: tage.thorstensen@nibio.no, May Bente Brurberg, phone: 92609364, e-mail: may.brurberg@nmbu.no

16	Crown rot in strawberry: Plant resistance and plant-pathogen interactions
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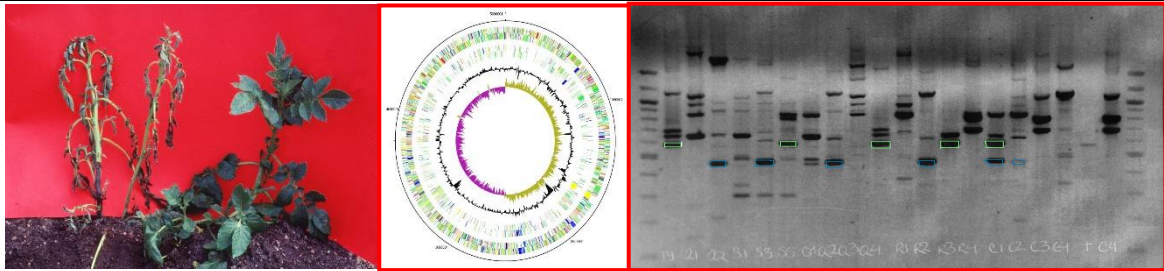


Background: Each year strawberry producers experience serious economical losses due diseases such as strawberry crown rot caused by *Phytophthora cactorum*. In an ongoing strategic institute program our main goal is to generate basic knowledge and identify genes and genetic markers that can be used as tools for the development of new resistant strawberry cultivars or more effective control measures for disease management. Such knowledge is highly required, and it will be invaluable in breeding for all kind of traits in all kind of crops.

You will learn: Standard molecular techniques such as cloning, PCR, real-time qPCR as well as plant and pathogen specific techniques.

For further information: May Bente Brurberg, phone: 92609364, e-mail: may.brurberg@nmbu.no
Professor May Bente Brurberg, IPV & NIBIO - Plant Health, Dept. of Biotechnology and Molecular Genetics.

17	Potato blackleg disease and <i>Pectobacterium atrosepticum</i>
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Background: In Norway and several other countries there has been an increase in potato blackleg disease during the last years. Potato blackleg is an important certifiable disease caused by the bacterium *Pectobacterium atrosepticum* (Pba). The disease may cause significant crop loss. Currently, there are no reliable chemical or biological methods to combat the disease once it has established itself in a crop. Latent infections are common and difficult to detect, and outbreak of the disease in an infected field is unpredictable, because the factors that trigger the outbreak are unknown.

The Master thesis will be part of a research project financed by the “Forskningsmidlene for jordbruk og matindustri”. The project aims at identifying genes, gene products, and regulatory mechanisms that are related to the bacterium’s pathogenicity (ability to cause disease). In other words, we are asking: How is *Pectobacterium* able to cause disease in the plant? What is triggering outbreak of disease?

You will learn: Standard molecular techniques such as cloning, PCR, real-time qPCR, in addition to using a bacterial mutation library and perform infection experiments. It is also possible to do bioinformatics analysis of transcriptome data.

For further information: May Bente Brurberg, phone: 92609364, e-mail:

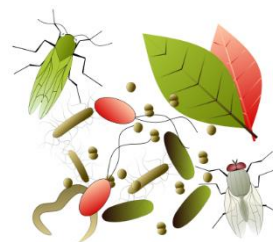
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18	Bioimmigrants – detection of invading species
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Invasive species and new plant pests and pathogens are introduced into new regions at an accelerating rate, due to increasing international trade with soil, plants and plant products. These invading species pose a severe threat to agriculture, forestry, urban and natural landscapes. Detecting and identifying plant pests and pathogens, like insects, nematodes, fungi, oomycetes, and bacteria requires various labour-intensive methods and expertise in several biological disciplines. In the ‘Bioimmigrants’ project, NIBIO experts from different fields collaborate on a common strategy to improve the detection and identification of invasive species, using metabarcoding that allows direct detection from soil and plant material.

We are looking for a master student who will contribute to the project by composing and validating artificial communities of relevant plants, insects and microorganisms. These communities will then be used to evaluate various experimental components, such as different DNA isolation methods, metabarcoding markers, amplification strategies and bioinformatics routines.

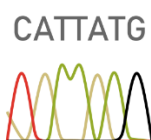


What you can learn

- Common and state-of-the-art molecular biology methods like traditional PCR, qPCR, barcoding by Sanger sequencing, metabarcoding by paired-end sequencing (Illumina Miseq)
- A complete workflow for micro- and macrobiome analysis using next-generation sequencing
- Basic bioinformatics analysis using Bash script and R
- Presenting your project and results comprehensively in talks and writing



Environmental DNA



Barcoding



Metabarcoding



Detection

Get in contact with us:

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19	Understanding the causal agent(s) of tip rot to reduce carrot loss and waste within the supply chain (RootCause)
	Two or more master theses in this project

Project background

Carrot is the main field vegetable in Norway, and it contributes over 461 million NOK per annum. It is stored in cold storages for up to 8 months, but postharvest yield losses reach 40%. In Norway, a disorder of carrot which is tentatively called “tip rot” has been observed with increasing frequency over the last 10 years. Tip rot significantly reduces root quality and contributes to the high level of carrot rejection during sorting and packaging. The causal agent(s) of tip rot are not known, and it is important to understand how biotic, abiotic and climatic factors affect the development of tip rot. The different work packages are presented in figure 1.

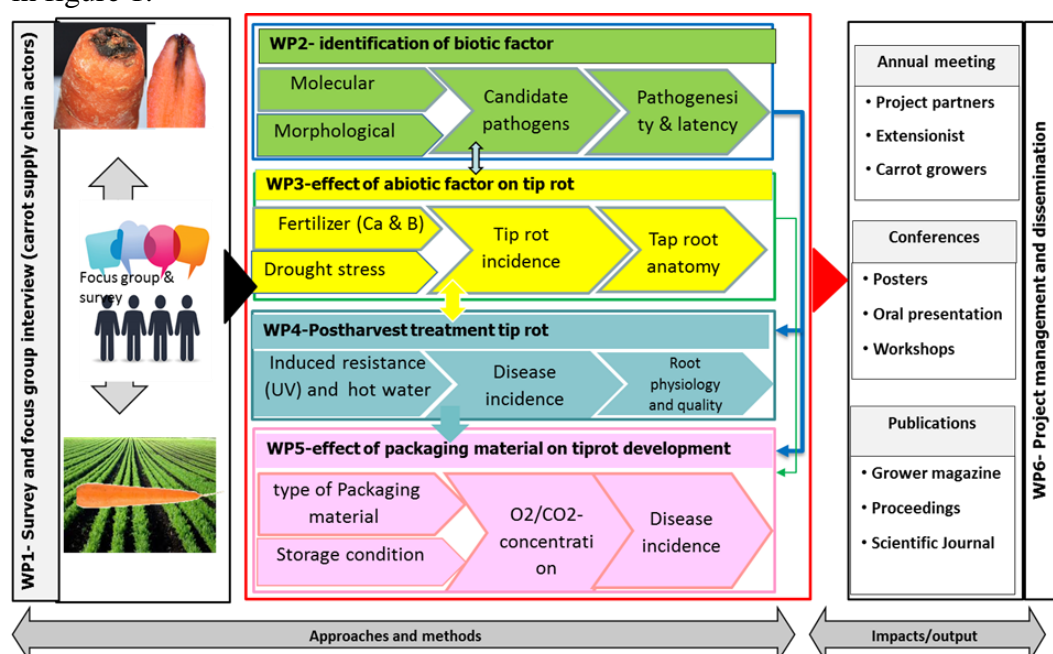


Fig.1. Flow diagram representing the hierarchical organization of the RootCause project. The work flow will start with farmer surveys (WP1), identification of pathogens (WP2) and abiotic factors (WP3) related to development of tip rot symptoms, postharvest treatment strategies (WP4) and effect of packaging materials (WP5) for sustainable management of tip rot. WP6 will address project coordination and dissemination.

<https://www.nibio.no/en/projects/rootcause?locationfilter=true>

The RootCause project involves a multidisciplinary team from national (NIBIO, NMBU, NOFIMA, and NLR), and international (University of Aarhus, and Warwick University).

The master theses will be part of a research project financed by the “Forskningsmidlene for jordbruk og matindustri” and support from industries.

For further information contact: Belachew Asalf Tadesse, phone: 93479432, e-mail:

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19.1 Identification of the causal agent(s) of tip rot in carrot

The thesis

The master thesis will focus on identification of pathogens of tip rot. Accurate identification of the causal agent(s) of tip rot is crucial to implement appropriate and effective disease management measures. We hypothesized that biotic agents such as fungi, bacteria and nematode are likely to play a principal role in tip rot disease development in carrot.

Methodology: First the microbial community associated with diseased and healthy carrots will be determined by use of **Metabarcoding (fig. 2)**: 1. Metabarcoding is a popular high throughput sequencing technology which consists of simultaneously amplifying a DNA fragment from the total DNA extracted from a sample. Different barcodes exist for different organisms, and thus it is possible to identify and distinguish bacteria, fungi, and other organisms found within the sample. 2. **Isolation of fungal pathogens**. At the same time potential pathogens will be isolated on selected growth media. 3. **Pathogenicity test and latent period**. Koch's postulates will be fulfilled by inoculating carrots with identified pathogens. The latent period, which is the delay between infection and symptoms development can vary from a couple of days to several months depending on temperature and other storage conditions. Therefore, the latent period of tip rot will be determined.

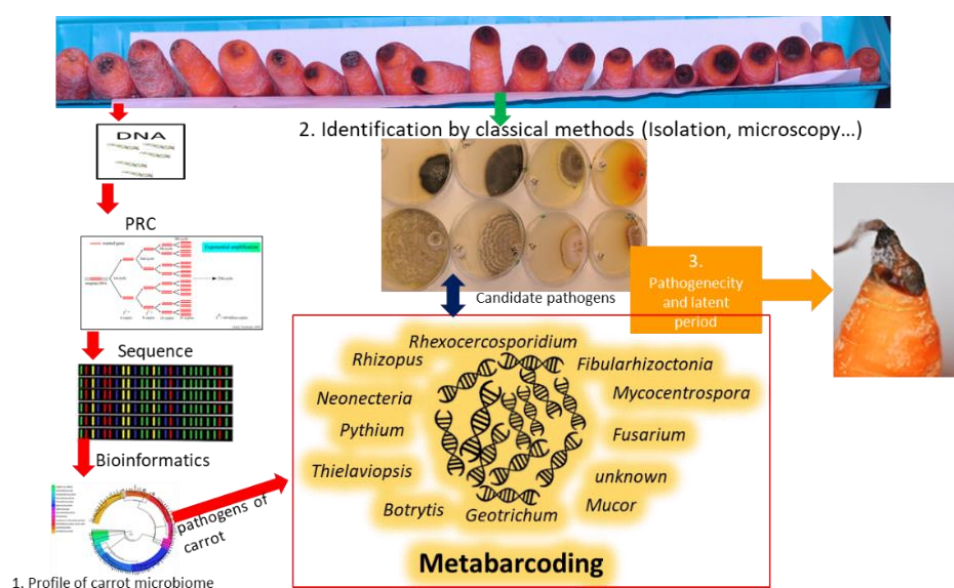


Figure2. overview of the procedure to identify the causal agent (s) of tip rot in carrot.

You will learn: the basics of plant pathology: pathogen identification by use of classical methods (incubation, isolation, and microscopy) as well as molecular techniques such as DNA extraction, PCR, metabarcoding, data analysis and writing. The master work can start from December 2019.

Supervisors:

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Erik Lysøe (NIBIO): erik.lysoe@nibio.no

19.2	Survey on carrot supply chain actors' knowledge and attitude to biotic and abiotic factors affecting tip rot
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Thesis

Norwegian carrot producers have many years of experience with diseases and tip rot in particular. Producers have seen tip rot appear in their crops, and may link it to certain practices, climatic events or other factors. Their experiences provide a knowledge base and may serve as valuable input to identify the causal agent. It is also important to know what measures are already being taken to manage tip rot, as well as the economic or social restrictions that may be a hindrance to implementing different agronomic and disease management practices.

Hypothesis: Carrot producers' knowledge and information on their agronomic practices will provide a basis for the identification of the causal agent(s) of tip rot. Determine the extent of the tip rot problem and its correlation with agronomic practices through producer interview

The master thesis will 1) **analyse focus group interviews and conduct a survey on farmers' attitude on tip rot**. A selection of different carrot producers has in focus group interviews shared information on their perception on the main cause(s) of tip rot, their knowledge about possible preventive measures, and what are the social and economic costs of taking these measures. This information will be used to develop a questionnaire to be used in a quantitative survey amongst all Norwegian carrot producers. This will provide us with data that will serve to quantify the prevalence of the disease in different regions in Norway. The database will also be used to quantify the various factors identified in the focus groups (for instance how common are different perception of causes and how many take certain measures to avoid tip rot), as well as allowing econometric analyses to identify causal links between some production characteristics and the occurrence of the disease.

2. **Survey - impact of agricultural practice on tip rot**. The common agronomic practices including soil type, nutrient content, cultivar, crop rotation, fertilization, pesticide use, irrigation practice will be collected in a standard form. Climatic data from closest weather station will be added to the data series. At the end of the carrot storage period, incidence of tip rot and other disease symptoms will be assessed by collaborators from NLR. Previously collected data from the tip rot pilot project and OPTIROT will as far as possible be included in the analyses.

You will learn: the basics of survey-based study, questionnaire development, quantitative and qualitative data analysis and writing.

Supervisors:

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Berit Nordskog (NIBIO): berit.nordskog@nibio.no

20	European canker (<i>Neonectria ditissima</i>)-cultivar and spore dispersal

Background

European canker caused by *Neonectria ditissima* is an important disease on apple in northwestern Europe. Development of fruiting bodies (perithecia) might be closely related to climate as well as dispersal of spores in different times during year. Spore dispersal and cultivar susceptibility is research topics in an ongoing project with research in Finland, Germany and Norway (KreftKamp 2017-2021).

Thesis

The master thesis can have two topics; 1: with focus on outer and inner symptoms of *N. ditissima* after inoculation. Visible symptoms will be assessed by stereo microscopy and isolation, and in addition qPCR can be used to quantify infected tissue when no visible symptoms.

The master thesis will in benefit from ongoing experiments in the project. The work can be organized either as field work during summer (at NIBIO Ullensvang), molecular work in autumn (at Ås) or both. NIBIO Ullensvang may host the student and offer a summer job/internship. 2: on assessing spores with a spore trap and counting in microscope. Development of perithecia will be assessed weekly in fruit orchards. The master thesis will in addition benefit of similar ongoing work in cooperating countries. The work will mainly be during autumn/winter time



European canker inoculum can be sexual (from red perithecia, left) or asexual (conidia in yellow white sporulation, right) on apple.

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21	Norwegian population of <i>Pseudomonas syringae</i> pathovars

Background

Pseudomonas syringae pathovars cause bacterial canker on stone fruit trees. Bacterial canker reduces tree yield potential by killing buds and branches/trees. The disease is the main focus in an ongoing project with a partner in Poland. To be able to control the disease in the orchards more knowledge is needed about the population of *Pseudomonas* we have in Norway and to compare the populations on imported trees with populations in the surrounding vegetation.



Dead flower buds and leaf spots on sweet cherry caused by *Pseudomonas syringae*.

Thesis

A master thesis may start in spring with the learning of isolation techniques at NIBIO, Ås. Bacterial isolates will be sampled throughout the growing season in stone fruit orchards and their surrounding vegetation. This field work will take place primarily in western Norway and may be combined with a summer job/internship at NIBIO Ullensvang. During autumn the obtained isolates will be characterized by chemical and molecular techniques at NIBIO in Ås.

Supervisors: Arne Stensvand (NMBU/NIBIO) arne.stensvand@nmbu.no, Juliana Perminow (NIBIO), May Bente Brurberg (NMBU/NIBIO), Jorunn Børve (NIBIO)

22	Biology of <i>Chondrostereum purpureum</i> , causal agent of silver leaf

Background

Silver leaf is an important disease especially in plum production, but may affect other fruit trees, deciduous forest trees and ornamental trees and shrubs. There is a lack of knowledge about the biology of the pathogen and risk of latent infections of the pathogen in production of transplants in nurseries.

Thesis

The master thesis work may include all or parts of the following three areas; 1. A population study with isolates of the pathogen. The work will mainly take place at Ås and have an emphasis on molecular methods. 2: Do inoculation experiments and assess development in different cultivars at NIBIO Ullensvang and assess the results together with ongoing studies. NIBIO Ullensvang may host the student and offer a summer job/internship. 3. Assess orchards for development of fruiting bodies of the silver leaf pathogen in cooperation with the Norwegian advisory service with purpose to gain knowledge of when the inoculum is present.

Supervisors: Arne Stensvand (NMBU/NIBIO) arne.stensvand@nmbu.no, May Bente Brurberg (NIBIO/NMBU), Venche Talgø (NIBIO) and Jorunn Børve (NIBIO)



Silver leaf can kill plum trees. If dead trees are left in the orchard they are an important inoculum source

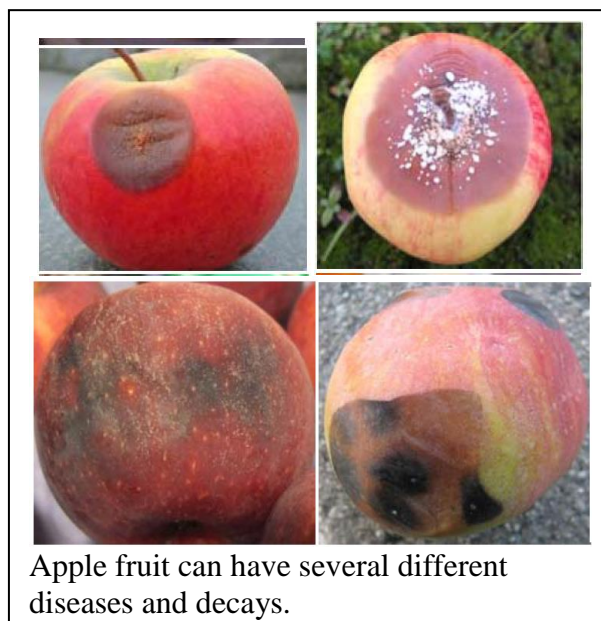
23	Postharvest diseases on apple, inoculation and storage experiments
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Background

Apple is the most important fruit crop in Norway. There is a lack of knowledge about the biology and risk for latent infections of the pathogen in young trees.

Thesis

The master thesis work has several options: 1. Storage experiments of inoculated fruit to gain basic knowledge about the relationship between fruit, storage condition and pathogen. The work will start in summer/early autumn and finish in December/January. 2: Sample pathogens in field during summer and autumn, do isolations and do identification with molecular methods in autumn/winter in order to gain new pathogen biology knowledge. 3. Storage experiments with focus on physiological decay in order to gain more knowledge about the mechanism and influencing factors. Can be focused on metabolism study at Ås, storage of fruit at Ås or at NIBIO Ullensvang. NIBIO Ullensvang may host the student and offer a summer job/internship.



Supervisors:

If pathology focus: Arne Stensvand (NMBU/NIBIO) arne.stensvand@nmbu.no, May Bente Brurberg (NIBIO/NMBU), and Jorunn Børve (NIBIO)

If storage/fruitquality/postharvest physiology focus: Siv Fagertun Remberg (NMBU) and Jorunn Børve (NIBIO)

24	Exploring fungicide resistance in cereal pathogens
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Fungicide resistance develops if certain fungal isolates in a population show an increased tolerance or reduced sensitivity to a certain plant protection product or product group. The major fungicide groups in Norway are strobilurines and triazoles. Strobilurines block mitochondrial respiration in fungi and triazoles inhibit demethylation of sterols which is critical for fungal cell wall growth. Single site mutations in the fungal genome can lead to changes in their uptake, metabolism and efflux of these fungicides. The isolates might carry these spontaneous mutations without any benefit until the fungicide they have become resistant to is applied. If this fungicide is applied once or several times, the more tolerant isolates will increase and dominate the population. We have seen strobilurine resistance in *Stagonospora nodorum* blotch isolates in Norway over several years. Based on molecular markers, we have also seen high levels of triazole resistance in *Septoria* leaf

blotch in Norway, but we have not seen reduced field performance so far. Once a fungal population becomes dominated by a resistant strain, the fungicide is not effective anymore and repeated sprays become redundant at an increasing environmental cost.



Three different fungal isolates on agar amended with different concentrations of azoxystrobin.

We need to map fungicide resistance in the most important cereal pathogens for strobilurines and triazoles to make sure we are not using fungicides with little effect. And we need to find out what drives fungicide development to design better anti-resistance strategies and keep the few fungicide groups we have effective.

A master thesis would involve collection and isolation of fungal strains from the field, fungicide testing on agar plates in the laboratory and small-scale greenhouse experiments with repeated inoculation experiments.

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