***Master- and Bachelor Thesis Topics 2021-2022***

Master-/bachelor-oppgaver

# Plant protection
# Plantevernfag

Her er mange forslag til spennende oppgaver innen plantevernfag, 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 faggruppelederen 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

| 1 Virus | **Jordboende virus i potet - skadepotensiale, spredning og bekjempelse** |
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| | *Soil-borne viruses of potato - loss, epidemiology and control* |

Potet med symptomer på rattelvirus (prøve til Planteklinikken høsten 2018). Dette var fra en åker der avlinga skulle vært førsteklasses «pommes frites», men rustflekksjuke forårsaket av rattelvirus ødela kvaliteten på deler av åkeren. Nå er spørsmålene mange – er sorten for følsom, ga forkulturen for mye smittebærende nematoder, kan samspill med ugras som vertplanter for virus og nematoder være viktig?

Det er aktuelt med en oppgave som kan fokusere på rattelvirus (Tobacco rattle virus) og dette viruset sitt skadepotensiale, spredning og bekjempelse. Ta kontakt med Dag-Ragnar Blystad (dag-ragnar.blystad@nibio.no ) dersom du er interessert i en oppgave innen dette temaet. Oppgaven blir definert nærmere i samtale med studenten og vil involvere medveiledere innen virus og nematoder dersom det er naturlig ut fra vinklingen på oppgaven.

| 2 Virus | Survey of *Tobamovirus* in sewage, drainage and environmental waters |
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Viruses represent one of the most important threats to agriculture and horticulture. Several viral families include highly stable pathogens, which remain infective and can be transported long distances in environmental conditions: sewage, wastewater and drainage. The diversity of plant viruses in these conditions in Norway is a big threat for plant health in circular agriculture. Especially viruses in the genera *Tobamovirus* can cause unpredictable loss to tomato and cucumber production in Norway.

*Tobamovirus* found in tomato, Ås, September 2019

The viral particles of tobamoviruses are extremely stable and infectious. They can be preserved in seeds for several years. In addition, tobamoviruses can survive outside of the host on inert and biological surfaces, as well as in water and soil for months or even years without losing their virulence. Due to import of tomato and cucumber as fresh vegetables and other products, we could be exposed to these viruses in our daily life, and infective virus particles may spread further into sewage, drainage and environmental waters which could be an unpredictable threat for plant health and food production in Norway.

To screen for tobamoviruses and other emerging plant virus presence in sewage, drainage and environmental water, and to evaluate their infection potential with testing on indicator plants is very important to get better prepared for any emerging viruses threatening horticultural production.

This is a project applied for, and we would like to involve a master student if this project is funded. Please contact Dag-Ragnar Blystad (dag-ragnar.blystad@nibio.no) or Zhibo Hamborg (zhibo.hamborg@nibio.no) for more information if you are interested in this topic.

| 3 Virus | Strawberry viruses and their diagnostic methodology |
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One of the causal agents, which can reduce fruit quality and quantity are viruses. Viral diseases can reduce strawberry yields by 20-40%, sometimes up to 70-80%, or the plants can even die due to viral infections. The use of classical methods (grafting of indicator clones, transmission electron microscopy, PCR) suggested that the most economically important strawberry viruses are strawberry mild yellow edge virus (SMYEV), strawberry crinkle virus (SCV), strawberry mottle virus (SMoV) and strawberry vein banding virus (SVBV), especially when it occurs in mixed infections. A new study showed that infection with only SMYEV caused a reduction in the number and size of strawberry fruit ranging from 28% to 63% compared to a healthy control.

Single virus infections usually do not show any specific symptoms on these plants, but only occurs when mixed viral infections are present. Therefore, often the most effective spreaders of viruses in strawberry are growers themselves, who unknowingly distribute diseased seedlings. Detection of viral pathogens and subsequent production of recovered seedlings is a very important prevention for the cultivation of healthy cultures.

We would like to develop a more cost-efficient and sensitive method to detect strawberry viruses with qPCR in a new KAPPA (Norway and Czech Republic collaboration) project starting from 2021. In addition, a survey of strawberry viruses in Norway and identification of unknown viruses that can infect strawberry cultures will also be studied in this project.

Please contact Dag-Ragnar Blystad (dag-ragnar.blystad@nibio.no) or Zhibo Hamborg (zhibo.hamborg@nibio.no) for more information if you want to study strawberry viruses in your master thesis.

| 4 Virus | Cryopreservation of plant viruses |
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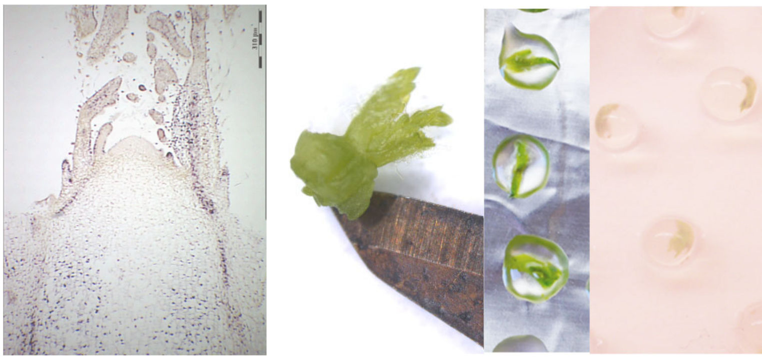
For plant viruses, positive controls for validation of diagnostic methods require special preservation methods to ensure long-term viability/infectivity of the sample and to maintain the original characteristics. Preservation methods that are commonly used are: low temperature storage at -20°C or -80°C, freeze-drying, and virus maintenance ex situ (such as greenhouse). The latter is needed when viruses can otherwise not be preserved, or viruses cannot be transmitted by mechanical transmission. It is difficult to grow virus infected materials continually without any changes and keep them free from other diseases and pests, risking to lose virus characterization. How to maintain these viruses has always been a challenge.

Successful preservation of apple stem grooving virus (ASGA), chrysanthemum stunt viroid (CSVd) and chrysanthemum chlorotic mottle virus (CChMVd) has been reported with cryopreservation without losing activity and infectivity afterwards. These data indicate that cryopreservation techniques have the potential to be applied for virus preservation.

In a new project (Norway and Czech Republic collaboration project starting from 2021- Healthy berries in a changing climate), we would like to apply cryopreservation in conservation of strawberry and raspberry viruses, by preserving plant materials that are infected with known viruses. Strawberry and raspberry infected with certain/several viruses can easily be cryopreserved, afterwards taken up and grown as tissue culture and further on in a quarantine greenhouse when good positive controls are needed. Certainly, validation of cryopreserved virus genetic stability, viability and infectivity is needed to evaluate this technique for broad application.



Relevant techniques such as localization and tissue culture will be included. Photo: Zhibo Hamborg.

Please contact Dag-Ragnar Blystad (dag-ragnar.blystad@nibio.no) or Zhibo Hamborg (zhibo.hamborg@nibio.no) for more information.

| 5 Virus | **Virus i bringebær – skadepotensiale, spredning og bekjempelse** |
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| | *Viruses of raspberry – loss, epidemiology and control* |

Det pekes ofte på at Norge har store muligheter for bærdyrking. Vi har entusiastiske og dyktige dyrkere som prøver å utnytte mulighetene. Det er imidlertid en bekymring at ikke plantehelse får nok fokus. Virussjukdommer i bringebær utgjør en flaskehals for å øke dyrkingssikkerheten. Det trengs for å forstå utfordringene med virus og hvordan virus best kan kontrolleres og bekjempes. Resultater fra prosjektet «*Diagnostikk, rensing og kryopreservering av bringebær, bjørnebær og sjalottløk*» (Rub&Al), 2016-2019, ga oss både ny kunnskap og nye diagnoseverktøy. I det nylig innvilgende prosjektet «*Healthy berries for a changing climate*» (KappaBerries), 2020-2024, får vi nye muligheter til å forske på virus i bringebær.

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| Mosaikk i bringebær – hvilke virus forårsaker slike symptomer? | Symptomer som skyldes *Black raspberry necrosis virus*, et av de mest utbredte og skadelige virus i bringebær i Norge. | Bringebær som smuldrer har vært undersøkt som et mulig virusproblem |

Det er aktuelt med en oppgave som kan fokusere på kartleggingsarbeid og de forskjellige virus i bringebær sitt skadepotensiale, spredning og bekjempelse. Men det kan også være oppgaver som er mer molekylært rettet og med fokus på ett virus. Det er også aktuelt å studere bladlus-overføring av virus i bringebær.

Ta kontakt med Dag-Ragnar Blystad (dag-ragnar.blystad@nibio.no ) eller Zhibo Hamborg (zhibo.hamborg@nibio.no) dersom du er interessert i en oppgave innen dette temaet. Oppgaven blir definert nærmere i samtale med studenten og vil involvere flere veiledere / medveiledere innen virus og entomologi etter hva som er naturlig ut fra vinklingen som defineres i samtale med studenten.

| 6 | CRISPR Cas13 for Virus localization and elimination |
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***CRISPR Cas13 (Not Cas9!)***

CRISPR Cas9 has caught the attention of many scientists during the last 5 years. There are many groups doing research on CRISPR Cas9 in plant biology. The focus of these groups is mainly on introducing new trains to plants by DNA modifications and to diversity the CRISPR toolbox for enhanced gene editing. My lab is focusing on CRISPR in a very different way. In my lab we are exploring a different Cas protein (Cas13a and the orthologues Cas13b and Cas13d) which does not target DNA, but rather RNA. In addition, my lab is not focusing on introducing traits or modifying the plant genome, but rather on using Cas13 as a method to localize plant viruses within the cells and to kill them. The thesis will be focused on characterizing the activities, cellular localization and ability to cleave viral RNA of Cas13 proteins. This type of study involves good amount of gene cloning and molecular techniques, the use of delivery vectors, plant cell transfections and cellular localization studies. This study is part of a CRISPR project in collaboration with China and might provide you the opportunity to spend some time in my colleague's lab in Beijing. If you are interested drop me a line.

Contact: Carl Spetz (carl.spetz@nibio.no)

| 7 | **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 (carl.spetz@nibio.no)

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| **8** | **Crown rot in strawberry: Plant resistance and plant-pathogen interactions** |
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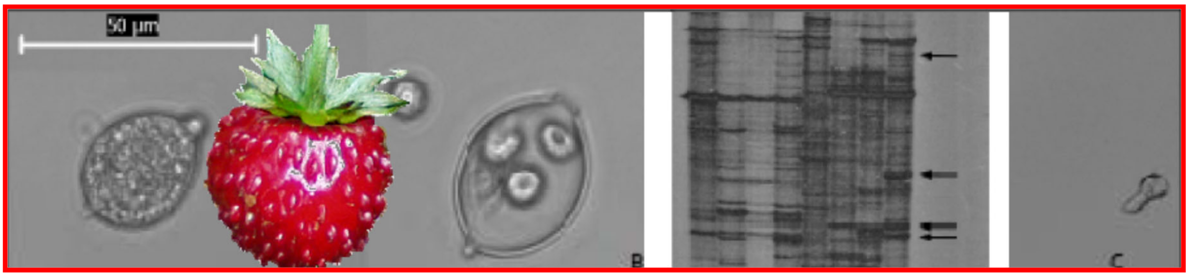


**Background:** Each year strawberry producers experience serious economical losses due diseases such as strawberry crown rot caused by *Phytophthora cactorum*. In an ongoing strategic institute program our main goal is to generate basic knowledge and identify genes and genetic markers that can be used 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.

| 9 | **Bioimmigrants – detection of invading species** |
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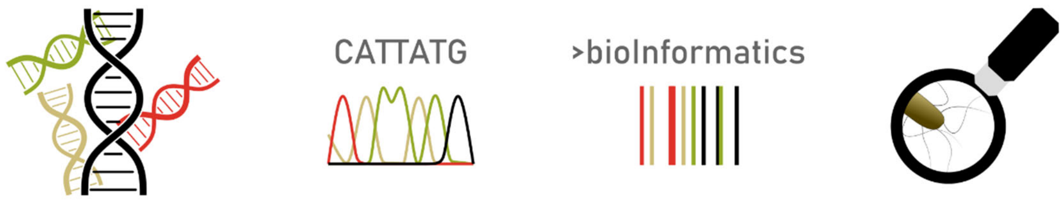
**Invasive species and new plant pests and pathogens** are introduced into new regions at an accelerating rate, due to increasing international trade with soil, plants and plant products. These invading species pose a severe threat to agriculture, forestry, urban and natural landscapes. Detecting and 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:**
Simeon Rossmann (NIBIO) simeon.rossmann@nibio.no
May Bente Brurberg (NMBU/NIBIO) may.brurberg@nmbu.no

| 10 | **Bitter rot, a main disease on apple with diverse symptoms and biology** |
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**Background.** Apple is the most important tree fruit crop in Norway. Bitter rot caused by species in the *Colletotrichum acutatum* complex is the main disease on apple fruit in Norway. Main parts of the disease development are clarified, but inoculum sources in spring has not been investigated. Neither has the exact identity of the pathogen, which has numerous other hosts.


Bitter rot on apple

**Thesis.** The master thesis can be focused in different directions depending on the student interests, e.g., 1. Molecular identification of isolates from a collection and own samples. The work will start with isolations from stored fruit, and finish with the molecular analysis before writing the thesis. 2: Inoculum sources. The work will start in spring with assessing possible inoculum sources and continue with harvest and storage of fruit in autumn. NIBIO Ullensvang may host the student and offer a summer job/internship.

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

| 11 | Norwegian population of *Pseudomonas syringae* pathovars |
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**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 *Psedomonas 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@nibio.no, Juliana Perminow (NIBIO), May Bente Brurberg (NMBU/NIBIO), Jorunn Børve (NIBIO)

| 12 | **Biology of *Chondrostereum purpureum*, causal agent of silver leaf** |
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**Background.** Silver leaf is an important disease in plum production, but may also affect other fruit trees, deciduous forest trees and ornamental trees and shrubs. There is a lack of knowledge about the biology of the fungus 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@nibio.no, ane.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

| 13 | **Postharvest diseases on apple, inoculation and storage experiments** |
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**Background.** Apple is the most important tree fruit crop in Norway. There is a lack of knowledge about the biology and risk for latent infections of the pathogen in young trees.

Apple fruit can have several different diseases and decays.

**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 knowledge on pathogen biology. 3. Storage experiments with focus on physiological decay in order to gain more knowledge about the mechanisms and influencing factors. Can be focused on a 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@nibio.no, arne.stensvand@nmbu.no, May Bente Brurberg (NIBIO/NMBU), and Jorunn Børve (NIBIO)

If storage/fruit quality/postharvest physiology focus: Siv Fagertun Remberg (NMBU) siv.remberg@nmbu.no and Jorunn Børve (NIBIO)

| 14 | Exploring fungicide resistance in cereal pathogens |
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**Background:** 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 Norwegain cereal production are triazoles, strobilurines/quinone outside inhibitors (QoIs) and succinate dehydrogenase inhibitors (SDHIs). 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 are 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 Septoria nodorum blotch isolates in Norway over several years. Based on molecular markers, we have also seen high levels of triazole resistance in Septoria tritici 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, a strobilurine.

**Goal:** We want 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 protect the few fungicide groups we have from losing efficacy.

**A master thesis** would involve collection and isolation of fungal strains from the field, fungicide testing on microtiter plates, molecular testing, bioassay and collection of field data from efficacy trials.

**Supervisors:** Arne Stensvand (NMBU/NIBIO) arne.stensvand@nmbu.no, arne.stensvand@nibio.no and Andrea Ficke (NIBIO) andrea.ficke@nibio.no

| 15 | **Population dynamics of yellow rust on Norwegian wheat** |
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**Background:** In May 2014 we discovered the first outbreak of yellow rust (*Puccinia striiformis*) on wheat in Norway after 30 years. Norwegian wheat cultivars used to be resistant to yellow rust, but now we see that almost all spring and winter wheat cultivars commercially grown in the country are again susceptible at various levels. Yellow rust can develop different races, which are named after the cultivars that are susceptible to them. Isolate analysis at the Global Rust Reference Center at Århus university showed that we have been invaded by a new rust race, called 'Warrior'. This is a race that has attacked many formerly resistant wheat cultivars all over Europe. Even though sexual reproduction of this fungus in Norway has not been reported, and yellow rust is transmitted by clonal uredospores, new races can emerge locally by mutations or be transported by wind currents over long distances. Since the outbreak in 2014, wheat breeders in Norway are trying to develop cultivars resistant to a broad range of different yellow rust races. But they cannot do this without knowledge about how the race population we have in Norway is changing.

Photo: Chloé Grieu

**Goal:** Map the occurrence of yellow rust races throughout the season, determine, where the primary inoculum comes from and how this biotrophic pathogen interacts with the necrotrophic leaf diseases, such as Septoria nodorum blotch to optimize fungicide applications that maintain productivity of susceptible cultivars.

**A master thesis** would include systematic collection of yellow rust samples from wheat hosts (winter and spring wheat) throughout the season to understand the sources of primary inoculum. Race identification based on SSR markers to monitor development of new races and break down of currently effective resistance genes. Concurrent inoculation of susceptible wheat cultivars with yellow rust and Septoria nodorum blotch to understand the effect of one disease on the other.

**Supervisors:** Arne Stensvand (NMBU/NIBIO) arne.stensvand@nmbu.no, arne.stensvand@nibio.no and Andrea Ficke (NIBIO) andrea.ficke@nibio.no

| 16 | **Predicting Sclerotinia stem rot on rapeseed in Norway** |
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**Background:** Sclerotinia stem rot (caused by *Sclerotinia sclerotiorum*) is a ubiquitous disease attacking many different crops. On rapeseed, the effect on yield highly depends on the weather conditions during flowering. Spores of *S. sclerotiorum* depend on easily acquired nutrients to infect their hosts. Flower petals falling in stem axils of oilseed rape are quickly colonized under wet conditions by the fungus before the stem is penetrated and the plant colonized from within. This pathogen produces sclerotia, which are melanized and densely packed mycelial masses that can survive in the ground for many years. Sclerotia will germinate and form apothecia under moist and temperate conditions to discharge windblown spores. This makes some agricultural areas highly unsuitable for growing crops susceptible to this pathogen. Sclerotinia stem rot has to be controlled by fungicides, as no resistant cultivars exist, but applications after flowering, when disease symptoms are apparent are less effective and can cause considerable damage to the tight canopy of rapeseed fields. Application of fungicides at the right time and aligned with the actual risk for infection remains very challenging. We have found that a range of humidity conditions can be suitable for successful infection of host tissue in the climate chamber, but we have not integrated our findings into a reliable risk prediction tool yet.

**Goal:** Determine the humidity range for sclerotinia stem rot infections under field conditions and develop an easy decision support tool to determine disease risk at flowering.

**A master thesis** would include field work at our field site in Ås and the surrounding area, setting up humidity stations, inoculation of rapeseed plants with *S. sclerotiorum* ascospores, disease monitoring, molecular testing and data analysis.

**Supervisors:** Arne Stensvand (NMBU/NIBIO) arne.stensvand@nmbu.no, arne.stensvand@nibio.no and Andrea Ficke (NIBIO) andrea.ficke@nibio.no