Examples of thesis topics (2016)
Group Horticulture & Product Physiology (HPP)

Students....
Students are welcome to do their BSc- and MSc-thesis research with one of the staff members, postdocs and/or PhD-students of the chairgroup HPP of Wageningen University (read the requirements you have to meet, which are presented on the webpage http://www.wageningenur.nl/hpp >> Education >> MSc- and BSc-thesis subjects HPP and Internships).
The BSc- and MSc-thesis topics of HPP are spread over themes encompassing pre-harvest environmental plant physiology to post-harvest product physiology, and are connected to horticultural production world-wide. The emphasis is on, but not restricted to, modern glasshouse production.
Yearly, many students participate via BSc- and MSc-thesis's. During their research period MSc-thesis students enroll a community of students and staff (known as STAIR [STudents Active In Research]), which facilitates the development of important research related skills such as proposal writing and presenting, progress presentations and research discussions.

Topics are example topics....
In this document you will find a list of possible actual topics. The list gives you an impression of the subjects we are working on. The actual definition of subjects is always affected by interests of students, equipment and facilities available and other students already working on the same project. If you have some ideas or proposals by yourself we can always discuss them.

For BSc- and MSc-students......
Most proposed topics in the list are primarily described as MSc-thesis topic. In general, parts of many of the described topics can also be done as BSc-thesis.

Interested? Always contact the coordinator.....
If you want to participate in a student-research-proposal at HPP, always contact the coordinator of the student-research-projects (Dr. Ep Heuvelink).

ep.heuvelink@wur.nl   tel. 4 83679

Make sure you do this in time:
Many of the listed topics require some preparation and certainly early planning from the student and researchers involved. This also takes time and may cause study delays if not initiated in time.

Although this document contains an extensive list of topics, it is not complete and may continuously be subject to changes. For the latest version check our website: http://www.wageningenur.nl/hpp >> Education
Pre-harvest topics

**LED-it-BE: Balancing Root:Shoot Ratio in Tomato with LED lights**

**Supervisor(s):**
Yongran Ji (PhD Candidate) and Dr. Ep Heuvelink

**Description:**
Dutch horticulture sector is seeking a breakthrough in reducing the energy cost in lighting, and the development of Light Emitting Diodes (LEDs) opens up new possibilities for researchers and growers to better tailor their light sources with increased energy efficiency. In recently granted STW programme LED-it-BE-50% we will tackle these challenges from different approaches. One of them is to investigate how assimilate partitioning is affected by the spectrum of LED lighting.

In this experiment we will focus on how different LED lighting scenarios can affect tomato’s root: shoot ratio. Furthermore we will try to explain such effect by analysing the influence of key plant hormones like Auxin.

Please contact the persons above for more detailed information.

**Type of work:**
Greenhouse/climate room experiments; phenotyping; plant growth analysis; statistics; when appropriate: molecular biology (gene expression analysis), plant hormone analysis

**BSc/MSc thesis:**
MSc thesis 24 or 36 ECTS

**Planning:**
February 2016
Interaction between cut-roses, powdery mildew and micro-climate: Greenhouse experiments and/or Functional-Structural plant modelling (FSPM)

Supervisor(s):
Arian van Westreenen and Prof. dr. Leo Marcelis

Description:
Growing of cut-roses (*rose x hybrida*) is very much affected by fungal diseases, such as powdery mildew (*Sphaerotheca pannosa var. roae*). There is a tight feedback between (1.) cut-roses, (2.) powdery mildew development and (3.) greenhouse climate. All these components can be modelled separately, however, all have their (dis)advantages. By combining these components into one 3D model, the complex plant-pathogen-climate feedbacks can be studied. This knowledge can be used to come up with optimized cut-rose management strategies to grow as much cut-roses as possible with as less energy as possible.

To develop the 3D model, dedicated experiments in greenhouses will be performed. During these experiments, variables like relative humidity (RH), temperature and lighting (e.g. intensity and spectra by LEDs) will be varied.

When you would like to be part of this project and to do research on one of these components by combining both experiments and modelling techniques, feel free to contact the coordinator.

Type of work:
Measurements in greenhouse on cut-roses, powdery mildew and/or micro-climate.
Working on a FSPM for cut-roses

BSc/MSc thesis:
MSc thesis 24 or 36 ECTS; part of this work can also be conducted as BSc thesis (18 ECTS)

Planning:
From March 2016 onwards
LED lighting strategies in tomato: modelling light and plant interactions with a Functional-Structural Plant Model (FSPM)

Supervisor(s):
Rachel Schipper (MSc.) and Prof. dr. Leo Marcelis

Description:
This project is part of the ‘LED it be 50%’ project. The 50% stands for the aimed reduction of energy usage in horticulture. The use of energy for lighting is the main bottleneck to decrease energy use in the horticultural sector. By using LED lighting in a smart way, the use of energy could be reduced tremendously. For smart and optimal use of LED light, the light and heat distribution through the canopy should be as optimal as possible. But what is optimal exactly?

This project will use a model on 3D light simulation and a Functional-Structural Plant Model (FSPM) to predict to (1) create a more homogeneous LED light distribution in the crop, resulting in a more efficient use of light energy and (2) reduce light losses to ground and sky. It helps us to find a most optimal LED lighting strategy.

An FSPM of tomato needs to be developed that incorporates features like transpiration and photomorphogenesis. However, no model can be calibrated without experimental input. An experiment in the greenhouse or climate room will be conducted to gather data on photomorphological and photosynthetic responses of tomato on different LED lighting strategies.

Are you interested in light and plant morphology interaction, LED application in tomato crop production, or functional-structural plant modelling? And would you like to combine both experiments and modelling? Feel free to contact the coordinator or the supervisors, and we can discuss the options and your interests. There are always many possibilities!

Type of work:
Experimental work in greenhouse/climate room, parameterization of photomorphological responses, modelling and/or programming with FSPM, literature research.

BSc/MSc thesis:
MSc thesis 24 or 36 ECTS; part of this work can also be conducted as BSc thesis (18 ECTS)

Planning:
From August 2016 onwards
Effects of light quality on plant water relations, leaf development and stem elongation

Supervisor(s):
Dr. Wim van Ieperen & PhD student or Postdoc

Description:
Several topics can be studied within the framework of a PhD project on the effects of light quality on plant water relations, and 2 postdoc projects, one on the effect of light quality on leaf development, and one on the effect of light quality on stem elongation. These projects are of fundamental scientific interest, as not much is known yet about the role of light quality during plant development on water relations and the underlying (molecular) mechanisms of light quality effects on leaf development and stem elongation. It is also of practical interest for horticulture e.g. because (1) the use of LEDs might enable the control of hardening of young plants before transplanting and (2) the use of LEDs might enable the production of compact potplants in greenhouses without the use of growth regulators.

BSc/MSc and ECTS:
Bsc thesis (18 ECTS)
MSc-thesis: 24-36 ECTS

Type of work:
Crop: tomato
Measurements: these topics include building and development of methodology, growing plants under different light qualities, measurements of physiological (e.g. photosynthesis and transpiration) and morphological parameters.

Requirements

Planning:
Start in consultation with Dr. Wim van Ieperen
Effects of light quality (LEDs) on leaf development – the role of phytochromes

Supervisor(s):
Dr. Dália Carvalho (Postdoc), Dr. Wim van Ieperen

Description:
Light Emitting Diodes (LEDs) open new possibilities to increase light (energy) use efficiency in the horticultural sector. In the current tomato production chain the use of LEDs might enable the control of hardening of young plants before transplanting. However, not much is known yet about the role of light quality during plant development on (1) the leaf initiation rate and (2) the timing of the initiation of the first truss. The leaf production rate by the shoot apical meristem has a large influence on the photosynthetic capacity of the young tomato plant, and sufficient assimilates is a prerequisite for production of good quality flowers and fruits on the first truss. Light quality (also intensity) is sensed by plant photoreceptors such as phytochromes.

The objective of this project is to evaluate the effect of light quality on leaf initiation and leaf initiation rate in the early stage of plant development and also advance on the understanding of the role of phytochromes on leaf initiation and leaf initiation rate by the use of phytochrome mutants.

BSc/MSc and ECTS:
Bsc thesis (18 ECTS)
MSc-thesis: 24-36 ECTS

Type of work:
Crop: tomato
Measurements: building and development of methodology, growing (in vitro) plants under different light qualities and intensities, measurements of morphological parameters.

Planning:
Start June 2016
Effects of diverse light recipes (LEDs) on the leaf development rate of contrasting tomato genotypes

**Supervisor(s):**  
Dr. Dália Carvalho (Postdoc), Dr. Wim van Ieperen

**Description:**  
Tomato cultivars vary in their response to light. Light Emitting Diodes (LEDs) open new possibilities to increase light (energy) use efficiency in the horticultural sector. However, not much is known yet about the role of light quality during plant development on (1) the leaf initiation rate and (2) the timing of the initiation of the first truss. The leaf production rate by the shoot apical meristem determines the photosynthetic capacity of the young tomato plant, and sufficient assimilates is a prerequisite for production of good quality flowers and fruits on the first truss. Growers prefer young plants from nurseries that have already developed a first truss, as this guarantees productivity of the plant.

The objective of this project is to evaluate the effect of four LED recipes on the leaf initiation rate and the timing of the first truss formation in young tomato plants from four genotypes that show phenotypic contrasts in their responses to light quality.

**BSc/MSc and ECTS:**  
Bsc thesis (18 ECTS)  
MSc-thesis: 24-36 ECTS

**Type of work:**  
Crop: tomato  
Measurements: building and development of methodology, growing (in vitro/ex vitro) plants under different light qualities and intensities, measurements of morphological parameters.

**Planning:**  
In consultation with the supervisor(s).
The role of environmental cues on potato flowering and tuberisation

**Supervisor(s):**
Faline Plantenga (MSc.) and Dr. Ep Heuvelink

**Description:**
Many crops including potato, have a vegetative (tubers) and a generative (seeds) reproduction system. In a large NWO project, the effect of environmental conditions (light spectrum and intensity, photoperiod, temperature, soil nutrients) on flowering and tuberisation and their physiological regulation is studied. Previous experiments looked at the effect of different light spectra and photoperiods on tuberisation and flowering, however, only an influence on tuberisation was found. The challenge at the moment is to find a way to influence and preferably accelerate flowering with environmental cues. Recent developments in the potato field have made hybrid breeding and the use of potato seeds for propagation possible, making potato flowering a new point of interest. Little research has been done on potato flowering in the past and therefore more information on this topic is needed and all new findings are helpful.

**BSc/MSc and ECTS:**
MSc-thesis: 36 ECTS

**Type of work:**
Climate chamber experiments with potato. LED lighting. Measurements: determination tuberisation and flowering time (macroscopic), plant characteristics (leaf area, dry weight, height etc.) and other measurements depend on which environmental factor will be tested (for instance spectral determination when looking at light quality).

**Optional:** gene expression studies (qPCR), protein analysis (western blot), assimilate determination (HPLC)

**Requirements**
The specifics for this experiment are not yet known so there is space to add your own ideas which makes this topic perfect for a creative, independent and motivated MSc. student.

**Planning:**
Starting July/ August 2016
Sink source relations in Strawberry

Supervisor(s):
Prof. dr. Leo Marcelis (HPP) ing. Jan Janse (Wageningen UR Greenhouse Horticulture, Bleiswijk)

Description:
Strawberry crops show sub-optimal sink/source balances during different phases of their development. Our hypothesis is that changes in the sink/source balance such as leaf picking or flower removal in young stages of plant development could lead to better fruit quality. The literature on this subject is not clear. Hypotheses need to be developed further, and tested by experiments in our Greenhouse in Bleiswijk.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Literature study, hypothesis development, writing a research plan, and carrying out experiments with leaf picking and fruit removal in our Greenhouse in Bleiswijk.

Requirements
Interest in crop physiology, plant cultivation. Interest in practical application of knowledge. Drivers licence.

Location
Bleiswijk (greenhouse experiment)
Wageningen (literature study and data analysis)

Planning:
January till July 2016
Phenotyping tomato genotypes for light use efficiency under different LED light regimes

Supervisor(s):
Dr. Theoharis Ouzounis, Dr. Ep Heuvelink

Description:
Plants are capable of perceiving and processing information from their biotic and abiotic surroundings in order to utilize it for optimal growth and development. Interactions between genotype and the environment hinder the predictive quality of phenotyping currently. Light quality (wavelength, i.e. colour), quantity (fluence rate) and photoperiod concurrently influence plant growth and metabolism. Tomato cultivars vary in their response to light. LEDs provide plant researchers and growers with exciting new possibilities to manipulate light spectrum and direction and to control light intensity, as well to save energy. Plants use blue and red light (since these wavelengths are efficiently absorbed by chlorophyll), but recent studies have shown that UV-B and far-red light also affect plant growth. All these wavelengths affect, among others, plant morphology, stomatal opening, photosynthesis, and secondary metabolism. Understanding the photomorphogenesis and photobiology of a big range tomato plants grown in confined environments under LED lighting will provide an insight to greenhouse horticulture and will provide information for light use efficient genotypes.

The main objective of this work will be to characterize the effect of eight LED light treatments on 40 different tomato genotypes. Thesis projects will use only 2 of these LED treatments. The project will finish the first screening in climate rooms until July 2016 and selected genotypes will be grown in autumn 2016 in greenhouses with different LED light regimes and focus in addition to stomatal phenotyping by using thermal and fluorescence imaging.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS; also BSc thesis (18 ECTS)

Type of work:
Climate chamber experiments
Crops: tomato plants
Measurements: destructive (leaf area, fresh and dry weight of leaves, stems, roots), stomatal conductance, chlorophyll, flavonol, and anthocyanin content, fluorescence measurements.

Planning:
January 2016 until April 2017
Developing an optimal nutrient solution for *Arabidopsis thaliana* envisioned for future space applications.

**Supervisor(s):**

*Dr ir Sander van Delden (daily supervisor)*

**Description:**

Many researchers use *Arabidopsis thaliana* as a model plant, but the nutrient solution that is used can differ significantly between university labs around the world. It has been shown that the nutrient availability can have a significant influence on plant development and gene expression. Much of the variation caused by using different nutrient solutions can be explained by differences in pH, electro conductivity (EC) and macro nutrient ratio’s. This research focusses on the relation between the provided nutrient solution and plant growth parameters like biomass accumulation, PS II efficiency, leaf appearance and time to flowering. For the substantial differences in these parameters gene expression could be investigated.

**BSc/MSc and ECTS:**

MSc-thesis: 24-36 ECTS

**Type of work:**

Climate chamber, growth cabinets, lab experiments and analysis.

**Plant(s):** *Arabidopsis thaliana* Wassilewskija (Ws) and Landsberg erecta (Ler)

**Methods:**

New methods of multifactorial optimisation of the nutrient solution, by using systematic variations in pH, EC and nutrient ratio’s that will be related to plant sap and dry weight analysis.

**Planning:**

In consultation with supervisor(s)
Exploring nitrogen regulation of transpiration in preparation for future space missions.

Supervisor(s):
Dr ir Sander van Delden (daily supervisor)

Description:
In a recent publication in the Journal of Experimental Botany, Matimati et al. (2014) concluded that nitrogen (N) regulation of transpiration controls mass-flow acquisition of nutrients. There seems to be a Gaussian curve of stomatal conductance in relation to N concentration in the root medium. The effect of N concentration on transpiration can potentially be an important finding for crop growth in any plant cultivation system. It could contribute to the well known effects of nitrogen increasing pathogen susceptibility, play a role in water use efficacy or photosynthetic rate. It could also be important for space plant cultivation. In space reduced gravity alters the amount of transpired water and the exchange of gases between the plant and its surroundings. The relation between increasing air movement and transpiration has been thoroughly studied, but the effects of nitrogen in the root environment is an additional factor effecting transpiration. Quantification of the relation between N concentration in the root environment and transpiration can have impact in both earth and space applications. Although the conclusions of Matimati et al. (2014) could be justified, the paper does not explain how this mechanism works. The material and methods describe that urea was used under very wet conditions the N concentrations were not measured and the form of N uptake (NH₄⁺, NO₃⁻, NH₃, urea) was not established. When urea breaks down under wet conditions nitric oxide (NO) can be formed which controls stomata aperture. Nitric oxide release could in itself explain the results of this study, something that is not accounted for in the discussion. Furthermore no measurements on EC, water potential and ion concentrations where conducted, so no direct quantitative relation between nitrogen concentration and stomatal conductance, transpiration and water use efficiency could be determined. This study will build on the publication of Matimati et al. (2014) and further explore the relation between N concentrations (NH₄⁺, NO₃⁻, NH₃, urea) and transpiration, photosynthetic rate, stomatal conductance and plant growth parameters.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Climate chamber, growth cabinets, lab analysis, LI-COR measurements.
Crop(s): Phaseolus vulgaris cv Star

Methods:
Using a hydroponic system different concentrations of nitrogen are created. Photosynthetic rate, stomatal conductance and transpiration rate will be determined by using a LI-COR CO₂/H₂O Gas Analyser. Additionally treatment effects are quantified by measuring plant development and growth parameters, i.e. biomass accumulation, leaf number, leaf nitrogen content etc.

Planning:
In consultation with supervisor(s).

Refs:
Modelling nutrient requirements of *Arabidopsis thaliana* in different growth environments: a preparation for future space missions.

**Supervisor(s):**
*Dr ir Sander van Delden (daily supervisor)*

**Description:**
Accurately capturing the relation of plant growth and development in relation to its abiotic conditions makes it possible to predict plant behaviour in different growth environments. This is not only important for resource collection in preparation for future space missions, it is also important during scientific space research. Highly accurate models can serve to anticipate plant nutrient demands based on integrated sensor readings. The sensors readings in a specialised plant growth cabinet (EMCS: European Modular Cultivation System) on the international space satiation (ISS) can, moreover, be used as model input to predict plant growth under earth conditions. Any difference between the model and observations can be attributed to microgravity conditions and serve as input for generating new scientific hypothesis. At present much has been done on modelling the growth and development of Arabidopsis. However even the most extensive Arabidopsis model (Chew *et al.* 2014) does not contain the modelling of nutrient dynamics.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Modelling

**Plant(s):** *Arabidopsis thaliana* Wassilewskija (Ws) and Landsberg erecta (Ler)

**Methods:**
Developing a mechanistic crop growth model for *Arabidopsis thaliana* by using previously gathered experimental data and literature data.

**Planning:**
In consultation with supervisor(s), project should be finished before 2017.
Know what to feed plants in space: a literature study on the nutrient solutions used for *Arabidopsis thaliana*.

**Supervisor(s):**
*Dr ir Sander van Delden (daily supervisor)*

**Description:**
Many researcher use *Arabidopsis thaliana* as a model plant, but the nutrient solution that is used can differ significantly between university labs around the world. This BSc thesis aims to provide a literature overview of the different nutrient solutions used in scientific research with Arabidopsis. It has been shown that the nutrient availability can have a significant influence on plant development and gene expression. Much of the variation caused by using different nutrient solutions can be explained by differences in pH, electro conductivity (EC) and macro nutrient ratio’s. These quantities are not always explicitly formulated in the material and methods, but can to some extend be calculated based on the nutrient mix reported. The literature overview ultimately aims to provide a meta-analysis on the effects of nutrient solutions used and plant growth. Aiming to answer the question if growth was limited by nutrient availability or deficiencies are to be expected.

**BSc/MSc and ECTS:**
BSc-thesis: 18 ECTS

**Type of work:**
Literature study

**Plant(s):** *Arabidopsis thaliana* Wassilewskija (Ws) and Landsberg erecta (Ler)

**Methods:**
Formulating search questions, reading, analysing and processing reported literature data.

**Planning:**
In consultation with supervisor(s).
A literature review on substrates used for plant space research

Supervisor(s):
Dr ir Sander van Delden (daily supervisor)

Description:
As recently extensively covered by the media astronauts on the international space station (ISS) have consumed the first plants that were cultivated in space. However, personal communication with researchers at NASA, revealed that the substrate of these lettuce plants was far from optimal. Wageningen University aims to develop a concept for optimal water and nutrient (W&N) delivery for plants cultivated in space. This development will involve making choices between different substrate system designs. To make an optimal choice a literature review will be done in cooperation with NASA (USA), Roscosmos (Rusia), and Cris (Norway).

BSc/MSc and ECTS:
BSc-thesis: 18 ECTS

Type of work:
Literature study
Plant(s): Lettuce and Arabidopsis

Methods:
Formulating search questions, reading, analysing and processing reported literature data.

Planning:
In consultation with supervisor(s).
Re-designing, testing and fine-tuning a water and nutrient delivery system as preliminary concept for future space missions.

Supervisor(s):
Dr ir Sander van Delden (daily supervisor)

Description:
The task of the Wageningen University in the European H2020 TIME SCALE project is to develop a concept for water and nutrient delivery for a new crop cultivation system (CCS) in the European Modular Cultivation System (EMCS). This involves the water and nutrient delivery hardware requirements, the software for water and nutrient regulation, and prediction of the plant’s water and nutrient demands. The system will contain state-of-the-art sensors for e.g. pH and ion specific concentrations. The system will mainly be build by Wageningen engineers in cooperation with space engineers. The hardware will require substantial testing, calibration and adjustment to become a robust prove of concept. This can involve the re-design of some system elements in cooperation with skilled space engineers in an international project. In short, this BSc thesis aims at testing, fine-tuning and documenting the newly developed water and nutrient delivery hardware at the Wageningen University growth facilities.

BSc/MSc and ECTS:
MSc/BSc-thesis: 18-36 ECTS

Type of work:
Climate chamber, engineering, hardware building, lab measurement and plant growth analysis.
Plant(s): Lettuce and Arabidopsis

Methods:
Testing, fine-tuning and documenting the newly developed water and nutrient delivery hardware at the WU growth facilities.

Planning:
In consultation with the supervisor(s)
Development of methodology for assessment of light stress in young tomato plants with malfunctioning stomata.

**Supervisor(s):**
Dr Wim van Ieperen and A. Bustamante (MSc, daily supervisor)

**Description:**
Stomata regulate CO₂ intake for photosynthesis and water transport, through the opening and closing of their apertures. Recent studies have shown that growing plants under constant high relative humidity (>85%) produce large stomata that are incapable of closing fully, even when induced to do so. This incapability can lead to excessive water loss of the plant through the leaves, especially when environmental conditions start to change (e.g. the RH lowers or light intensity increases). The resulting water stress may lead to a lower water status and a higher vulnerability to light and heat stress.

In this research project we would like to investigate two related things. 1. In the past several methods, of which some are based on gas exchange chlorophyll fluorescence gas exchange of leaves, have been used to measure the degree of light stress. We would like to develop a method that enables the quantification of the vulnerability to light stress of plants grown under different light/RH combinations. 2. The physiological backgrounds of differences in vulnerability to light stress of plants grown under different light/RH combinations.

Finding the best mean to evaluate light stress in plants grown under high relative air humidity will give us a better understanding in the factors affecting the photosystem in accordance to the stomatal development and functioning.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Climate chamber, growth cabinets, and lab experiments
Crop(s): Tomato var. “Cappricia RZ”, “Ailsa Craig”, “MM”, “Ruby”, “8561”

**Planning:**
In consultation with the supervisor(s)
Stomatal responsiveness of young tomato plants to variations in relative air humidity and light intensities.

**Supervisor(s):**
Dr Wim van Ieperen and A. Bustamante (MSc, daily supervisor)

**Description:**
Stomata regulate CO₂ intake for photosynthesis and water transport, through the opening and closing of their apertures. Recent studies have shown that growing plants under constant high relative humidity (>85%) produce large stomata that are incapable of closing fully. Even when presented with closing incentives like darkness, desiccation or abscisic acid, the stomata guard cells are unable of functioning properly. This incapability can lead to excessive water loss of the plant through the leaves, especially when environmental conditions start to change (e.g. the RH lowers or light intensity increases). The resulting water stress may lead to a lower water status and a higher vulnerability to light and heat stress.

Currently, all studies on high air humidity and stomatal responsiveness have been done at low growth irradiance, so far, it is unknown if the problem also occurs when growth light intensity is high. We hypothesize that plants grown on high relative humidity and high light intensities will not become unresponsive as they would be subject to a higher evaporative demand than plants grown under low irradiance. The aim of the research will be to determine the responsiveness of stomata of young tomato plants grown under a variety of conditions of relative humidity and light intensity. This will give insight in the stomatal development and regulation under these conditions.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Climate chamber, growth cabinets, and lab experiments
Crop(s): Tomato var. “Capricia RZ”, “Ailsa Craig”, “MM”, “Ruby”, “8561”

**Methods:**

**Planning:**
In consultation with the supervisor(s)
Light stress vulnerability of young tomato plants grown in contrasting relative air humidity and light intensities.

**Supervisor(s):**
*Dr Wim van Ieperen and A. Bustamante (MSc, daily supervisor)*

**Description:**
Although light acts as the main energy source for photosynthesis, high light intensities can be harmful for plants. If excessive light is not dissipated or avoided efficiently/properly then damage to the photosynthetic apparatus can occur. This damage can be reversible if the stress caused by high light is moderate and irreversible damage occurs when the stress is more severe. Most studies on light stress have been carried out with leaves grown under moderate air humidity levels, however, it is not uncommon for plant leaves to be exposed to environments of high RH – like in dense canopies or closed greenhouse systems. Recent studies have shown that growing plants under constant high relative humidity (>85%) produce unresponsive stomata that are incapable of functioning properly, and so far, it is unknown if these plants would respond equally when subjected to high light levels as plants grown on moderate RH conditions.

We hypothesize that plants grown on high relative humidity and high light intensities will not develop unresponsive stomata and therefore will be capable of withstanding higher light intensities without a stress response. The aim of the research will be to better understand the vulnerability to high light of plants with unresponsive stomata (grown at high air humidity), their capacity to cope with light stress and the physiological backgrounds of interactions between water stress and light stress in leaves.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Climate chamber, growth cabinets, and lab experiments

**Crop(s):** Tomato var. “Cappricia RZ”, “Ailsa Craig”, “MM”, “Ruby”, “8561”

**Methods:**
Leaf gas exchange measurements – Chlorophyll fluorescence (CF) techniques – Stomatal and non-stomatal limitations of photosynthesis – Detailed analysis of CF quenching parameters obtained by imaging (CF-camera) and non-imaging techniques will be used to investigate differences in the capacity of leaves to cope with excess energy between the treatments – Fresh and dry weight measurements.

**Planning:**
In consultation with the supervisor(s)
**Water stress and light quality: Coordination of Leaf hydraulic conductance and stomatal conductance at different light qualities (i.e. under LEDs and Sun-light)**

**Supervisor(s):**  
Dr. Wim van Ieperen

**Description:**  
When leaves adapt to environmental conditions they apparently show coordinated responses with respect to photosynthesis and water relations. This requires some kind of internal organisation, which might possibly be under the control of an environmental factor. Recently we showed that the conductance for water transport in the leaf lamina ($K_{leaf}$) and stomatal conductance ($g_s$) are highly correlated, even when plants are grown under distinct different light qualities (Savvides et al., *Journal of Experimental Botany*, 2012) which might point to a specific role for some photoreceptors (i.e. phytochromes, cryptochromes etc). This topic is of fundamental scientific interest, as not much is known yet about the role of light quality during plant development on water relations. It is also of practical interest for horticulture e.g. because the use of LEDs might enable the control of hardening of young plants before transplanting.

**BSc/MSc and ECTS:**  
MSc-thesis: 24-36 ECTS

**Type of work:**  
Crops: tomato, cucumber  
Measurements: the topic includes building and development of methodology, growing plants under different light qualities, measurements of $K_{leaf}$, stomatal conductance and stomatal -aperture, -size and -densities. Measurements of photosynthesis and transpiration and biomass accumulation

**Planning:**  
Start in consultation with supervisor  
For this MSc-project basic technical skills are required (further info: wim.vanieperen@wur.nl)
UV as regulator of developmental processes in plants

**Supervisor(s):**
*Dr. Wim van Ieperen*

**Description:**
Recently, a UV-B photoreceptor has been discovered. It is assumed to influence a broad range of physiological processes, but details are lacking. Many greenhouses filter UV-B from solar light spectrum. It is unclear what impact this has on processes such as: flower induction, elongation, stress tolerance, leaf initiation and development. In the scientific literature some suggestions have been made but not much is clear yet.

**BSc/MSc thesis:**
Several BSc thesis’s and possibly an MSc-thesis

**Type of work:**
- Literature study
- Short Climate chamber and or in vitro experiments with UV has light factor

**Planning:**
To be scheduled after consulting the supervisor
Analysis of realistic ‘genotype by environment’ interactions simulated using a crop growth model with a large number of physiological parameters

**Supervisor(s):** Dr. Ep Heuvelink and Prof. Dr. Fred van Eeuwijk (WUR Biometris)

**Description:**
A different response of genotypes across environments is frequent in multi-location trials and is known as genotype by environment interaction (GxE). The study and understanding of these interactions is a major challenge for breeders and agronomic researchers. To better understand the GxE a simulation study may be conducted using a crop growth model with a large number of physiological parameters, to obtain yields for different genotypes in different environmental conditions. Yields of different genotypes across environments should be analysed with some of the standard techniques to study GxE (e.g. AMMI models, mixed linear models, etc.) in order to answer questions such as:

(i) are the GxE interactions significantly important? (e.g. are crossovers present in the data?);
(ii) which kind of parameters make the GxE stronger?
(iii) which characteristics (regarding parameter specification) should have the genotypes to have higher yield in a particular environment?
(iv) which parameters are the most important to explain the final yield?

**BSc/MSc and ECTS:**
MSc-thesis: 24 or 36 ECTS

**Type of work:**
Desk study thesis on modelling/simulation/analysis.

**Requirements:**
Interest in quantitative methods. Some knowledge of crop growth models and good statistical knowledge, preferably including multivariate methods.

**Planning:**
The thesis can start at any moment in the academic year 2015/2016 - In consultation with the supervisor(s).
Source-sink ratio and negative feedback of low sink strength on crop photosynthesis

Supervisor(s):
Dr. Ep Heuvelink and Prof. Dr. Leo Marcelis

Description:
Light is the most important growth factor determining crop yield in greenhouses. In northern regions including The Netherlands, low light levels limit photosynthesis and consequently growth during a large part of the year. On the other hand in summer time there are periods with too high intensities, which may lead to photo-damage or reduction of the quality of produce.

The overall objective of this project is to identify and quantify possibilities for increasing Light Use Efficiency (LUE; g per MJ intercepted PAR) in greenhouse crops. The MSc thesis work will focus on the reduction in LUE which may result from a limitation by sink demand. Occurrence of feedback inhibition of photosynthesis may limit LUE. In this project the importance of sink demand for LUE will be investigated in tomato cultivars with different fruit sizes (sink strengths).

BSc/MSc and ECTS:
MSc-thesis: 24 or 36 ECTS

Type of work:
Determine the source-sink ratio for several tomato cultivars.
Determine whether tomato cultivars differ in their feedback inhibition of plant growth.
Greenhouse experiment and laboratory measurements, including leaf photosynthetic properties, stomatal conductance, content of carbohydrates, leaf area expansion and orientation.

Planning:
In consultation with the supervisor(s)
A Functional Structural Plant Model (FSPM) for lettuce growth in urban horticultural production systems

Supervisor(s):
Prof. dr. Leo Marcelis

Description:
3D simulation of plant function and structure is a vital and a growing international scientific research field. The last decade the methodologies for 3D simulation of plants have improved enormously. 3D simulation of plant function and structure enables researchers to address very interesting scientific questions as well as practical questions in horticulture. For instance understanding the consequences of different distributions of light in canopies for leaf and crop photosynthesis, which is being applied in the development of light diffusing materials and LED lighting systems.

‘Urban farming’ is food production in and around the city. Urban farming is considered a promising development in the light of societal challenges regarding food security and urbanization, and sustainable crop production (FAO 2011, Colding & Barthe 2013). Growing vegetables in multilayers in buildings without solar light is a form of urban farming, attracting a lot of attention worldwide. Experiments by Philips with Light-emitting Diode (LED) systems for multilayer cropping facilities indicate that the growing of crops in multistorey warehouses close to the point of consumption is technically feasible and promising. To make these systems economical profitable the growth process needs to be fully optimised. Models can help to guide in order to find the most optimal production system.

BSc/MSc and ECTS:
MSc-thesis: 36 ECTS

Type of work:
• make a research plan
• get acquainted with FSPM models and Groimp (see http://www.grogra.de/)
• make a survey of existing lettuce models
• program an FSPM for lettuce able to simulate light absorption, crop photosynthesis, leaf growth and plant development
• A lettuce experiment can be conducted in order to gather experimental data that can be used for model development, calibration and/or validation.

Planning:
flexible - In consultation with the supervisor(s)
Design of LED based production systems for tomatoes: optimization of lamp and plant characteristics

Supervisor(s):
Anja Dieleman (Wageningen UR Greenhouse Horticulture) and Ep Heuvelink

Description:
Over the last decades, the use of assimilation lighting (and thereby electricity consumption) in greenhouse horticulture has increased by 10% per year to fulfill the demands of the market of year-round high quality products. LED technology creates a unique opportunity to realize LED-based production systems which can reduce the carbon footprint by up to 45% compared to conventional High Pressure Sodium lighting systems. In the project Carbon-LED, we will design new LED based production systems with a low carbon footprint, i.e. new lamp types, selection of tomato genotypes and design of the cultivation system. In this project Philips and Nunhems co-operate with Wageningen UR to realize these goals. This thesis topic is part of the Carbon-LED project.

The goal of the thesis topic is to evaluate new, experimental LED systems that will be developed by Philips in spring 2015 and varieties selected by Nunhems based on plant characteristics that result from scenario studies by a 3D functional-structural plant model. These lamp types and varieties will be evaluated under crop management systems which were selected based on modelling studies and current knowledge and experience, obtained from previous research projects, field trials and experience from growers. In the greenhouse evaluation trial, plant characteristics under these new LED based production systems will be evaluated. For this, advanced plant measurements will be done, such as light interception, photosynthesis, leaf morphology, and fruit development. The data will be analyzed and effects of separate processes will be linked to leaf or plant characteristics. In the Carbon-LED project, the data obtained will be fed back to the 3D model, LED design, variety selection and will be used to assess the carbon footprint and adaptive value of the systems evaluated.

BSc/MSc and ECTS:
BSc/MSc-thesis: 24 - 36 ECTS

Type of work:
Greenhouse experiment, measurements of light intensity and spectrum, and plant characteristics such as light interception, leaf morphology, fruit development rate and size. Data analysis, integration of components in a conceptual model and suggestions for the improvement and implementation of a LED based production system for greenhouse horticulture.

Requirements:
Interest in plant physiological processes, horticulture, co-operation with companies (Philips, Nunhems), plant morphology, LED design or plant breeding.

Location:
Location experiment: Bleiswijk, location desk work: Wageningen or Bleiswijk

Planning:
Approximately September 2015 – May 2016
Pre- to Postharvest Topics

Sweet Pepper+ : increasing health and flavour of sweet pepper by cultivation methods

Supervisor(s):
Supervisors: Prof. dr. Leo Marcelis (or someone else at HPP) and ir. Caroline Labrie (Wageningen UR Greenhouse Horticulture, location Bleiswijk)

Description:
Among consumers there is an increasing interest in tasty and healthy food. Recently we found that local LED light on tomato fruits during their development on the plant, doubled their Vitamin C content (L-ascorbic acid). Sweet pepper has already high amounts of Vitamin C and antioxidants and is therefore an interesting fruit to further increase its flavour and nutritional content. The general objective of the Sweet pepper+ project is to increase nutritional content and flavour of sweet pepper by cultivation methods. The Sweet pepper+ project is part of the public private partnership ‘Tasty marketing of healthy fruits and vegetables’, aiming to increase consumption of fruit and vegetables by an integration of technical and consumer research. This is a collaboration of twenty private companies; breeders, growers and some greengrocers.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
A combination of desk study, experimental work and laboratory analysis. A desk study has to be carried out about the effect of different cultivation methods on flavour and nutritional content of sweet pepper. For the cultivation method with the highest potential and future practical application, greenhouse experiments will be carried out during summer and autumn 2015. A grower in Naaldwijk offered to use a part of his greenhouse with sweet pepper for this project. Laboratory work are mainly measurement of sugars and bioactive compounds (vitamin C, carotenoids) of fruits.

Requirements:
Interest in flavour and health of greenhouse fruits and vegetables. Interest in practical application and some communication skills with growers. Interest in metabolic processes. Basic laboratory skills. Drivers licence.

Location:
Location is Bleiswijk (Zuid-Holland).
Greenhouse experiments will be at a grower in Naaldwijk.

Planning:
Somewhere between dec. 2015 and nov. 2016.
Greenhouse experiments will be somewhere between dec. 2015 and sept. 2016.
Manipulating translucency in cut tomato by preharvest treatments

Supervisor(s):
Supervisors: dr. Rob Schouten (and Prof. dr. Ernst Woltering FBR)

Description:
Among consumers there is an increasing interest in tasty and healthy food. Recently we found that local LED light on tomato fruits during their development on the plant, doubled their Vitamin C content (L-ascorbic acid). Tomato is an important horticultural crop and the most consumed nonstarchy vegetable. Therefore it is an interesting fruit to further increase its flavour and nutritional content. The general objective of the Tomato+ project is to increase nutritional content of tomato by cultivation methods. The Tomato+ project is part of the public private partnership ‘Tasty marketing of healthy fruits and vegetables’, aiming to increase consumption of fruit and vegetables by an integration of technical and consumer research. This is a collaboration of twenty private companies; breeders, growers and some greengrocers.

BSc/MSc and ECTS:
MSc-thesis: 24 - 36 ECTS

Type of work:
A combination of desk study, experimental work and laboratory analysis. A desk study has to be carried out about the effect of different cultivation methods on flavour and nutritional content of tomato. For the cultivation method with the highest potential and future practical application, greenhouse experiments will be carried out during summer and autumn 2015.

A grower in Pijnacker (Zuid-Holland) offered to use a part of his greenhouse with tomato for this project. Laboratory work are mainly measurement of sugars and bioactive compounds (vitamin C, antioxidants) of fruits.

Requirements:
Interest in flavour and health aspects of greenhouse fruits and vegetables. Interest in practical applications and some communication skills with growers. Interest in metabolic processes. Basic laboratory skills. Drivers licence needed.

Location:
Location is Bleiswijk (Zuid-Holland).
Greenhouse experiments will be at a grower in Pijnacker (Zuid-Holland).

Planning:
In consultation with the supervisor(s)
LEDs in improving Vitamin C in tomato fruit: a greenhouse application

**Supervisor(s):**
N. Ntagkas (MSc), Prof. Dr. E. Woltering and Prof. Dr. L. Marcelis

**Description:**
Vitamin C (L-ascorbate) is a phytochemical essential for human health, found in plant tissues. We are developing methods for improving vitamin C levels of greenhouse grown tomato fruit by the use of LED lights.

So far we have determined lighting strategies that lead to more than 4 times the standard vitamin C levels found in tomatoes. Optimal intensities, durations and light colors are defined. Several cultivars are tested. On the same time we investigate the physiological pathways for light upregulation of vitamin C.

At the last stage of this PhD project we will investigate the potential application of a relevant system in greenhouse conditions. Tomato trusses will be illuminated in the greenhouse with LEDs. The impact of this light on vitamin C as well as the quality of these fruit will be assessed. We will compare the response of fruit that are attached on the plant with the response of detached fruit.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
The student will be stimulated to work under a conceptual framework in building and conducting a greenhouse experiment on the effect of LED light on vitamin C levels of tomato fruits. Modern techniques on detection of vitamin C, soluble carbohydrates and organic acids (HPLC), respiration (gas exchange), photosynthesis (fluorometry) will be employed. Fruit color and firmness measurements will take place.

**Requirements:**
standard requirements for a thesis with horticulture and product physiology.

**Planning:**
In consultation with the supervisor(s)
Post-harvest topics

Vase life of cut flowers; Influence of pre- and postharvest conditions

Supervisor(s):
Dr. Julian Verdonk and Dr. Rob Schouten

Description:
Cut flowers are a popular luxury product, and are an important part of the Dutch export market. Preharvest and postharvest (long transport/storage) conditions can have an unpredictable effect on vase life.

Vase life is the result of the interacting processes: water balance, carbohydrate starvation, and senescence. Water balance is the balance between water uptake and water loss. For most cut flowers the water balance becomes negative after some days in a vase with water. Xylem vessels and stomata are both essential for the maintenance of a good water balance. Water uptake can be negatively affected by the presence of air emboli or bacteria in xylem vessels, as well as wounding responses at the cut stem surface that clog the vessels. Water loss is dependent on the regulation of stomata closing in the leaves. Water balance is dependent on postharvest treatment, genotype, but also on growth conditions. This xylem architecture is dependent on genotype, but also on preharvest growth conditions such as water supply. The same is true for stomatal control; it is dependent on preharvest conditions, especially air humidity, but has also been shown to be dependent on genotype, at least in Arabidopsis and Rose. Senescence in flowers is an important developmental process of the flower branches, often hastened by pollination, localized wounding, aging and pathogen attack. The exhaustion of carbohydrates during storage has a quantitative effect on vase life, and is dependent on genotype. In some genotypes vase life is more quickly reduced, just because of faster exhaustion of nutrients and/or carbohydrates than in others.

A thesis project on this topic can be on the preharvest growth conditions, or the postharvest conditions.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Crops: Chrysanthemum, Bouvardia, other cut flowers

Measurements: vase life, stomatal conductance, microscopy, physiology of the flower and stem

Planning:
Flexible starting time.
The one fibre spectrophotometer: from cancer detection to assessing quality of fruits

**Supervisor(s):**
*Supervisors: dr. Rob Schouten (and Prof. dr. Ernst Woltering FBR)*

**Description:**
Non-destructive skin cancer detection is successful using a new type of measurement device that makes use of light information that is normally discarded. It uses neither reflection nor absorption information after applying light, but scattering information. We want to investigate if this one-fibre spectrophotometer can also be used to obtain new information from fruits. We want to investigate whether we can easily quantify levels of health/quality related compounds such as chlorophyll, lycopene, anthocyanins and glucosinolates with new possibilities (use your imagination) to be explored.

We want to explore a few cases, that vary from quantifying senescence in cut flowers (roses, effect of rehydration, effect of cold storage) and senescence of cut lettuce (chlorophyll measurements, effect of cold storage, assessment of glucosinolates), detection of chilling injury (cucumber, low temperature storage) and ripening of tropical fruit (firmness, dry matter at varying storage temperatures).

Can you find new applications using information in spectra that were discarded up till now?

**BSc/MSc and ECTS:**
MSc-thesis: 24 - 36 ECTS

**Type of work:**
A combination of experimental work and laboratory analysis.

**Requirements:**
Affection with spectroscopy. Interest in quality and health aspects of greenhouse fruits and vegetables. Interest in practical applications and programming (LabVIEW). Basic laboratory skills.

**Location:**
Radix and FBR (Wageningen)

**Planning:**
Can start anytime.
Increasing keeping quality and flavor of strawberry as affected by postharvest light treatments

**Supervisor(s):**
dr. Rob Schouten and Julian Verdonk (and ir. Caroline Labrie (Wageningen UR Greenhouse Horticulture, location Bleiswijk)

**Description:**
Keeping quality of strawberries is still a major issue during postharvest varying between a few days to up to 14 days. Keeping quality is limited due to botrytis infection. At the same time long keeping quality strawberry often have low levels of sugars and flavour compounds resulting in poor taste. Some time ago a common precursor was found for anthocyanin (red colour) and proanthocyanidins (botrytis inhibitors). At high temperatures, more anthocyanin is formed (fast ripening), at low temperatures more proanthocyanidins are formed (better resistance against botrytis). The biosynthetic pathway towards these compounds is well known, and instead of measuring anthocyanin, proanthocyanidins and sugars, we can also look at the expression of the genes involved in their production. We would like to investigate the effects of light (quality and quantity) on both keeping quality and volatile production. Can we steer towards more botrytis protection with red or blue LEDs? What is the effect of these light treatments on the flavour compounds? Can we uncouple volatile and colour formation using light treatments?

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Strawberries will be produced in a related Greenhouse Horticulture project and postharvest storage and light treatment will take place in Wageningen. Work includes HPLC, colour and GC-MS (volatile) measurements and gene expression analysis. Because of the workload, this work is preferably done with two students. Alternatively, a selection of preferred experiments and techniques that you want to use can be made.
At the plant level, you will work with an established experimental system in climate chambers.
Crop: cut Chrysanthemum (Chrysanthemum morifolium)
Measurements: image analysis, quantitative PCR, HPLC

**Planning:**
In consultation with the supervisor(s)
Tomato taste development

Supervisor(s):  
Dr. Rob Schouten

Description:  
Taking biopsies over time in order to measure repeatedly e.g. sugar or acid levels of the same fruit is turning out a useful technique. We have optimised this technique and now would like to make the next step. This MSc thesis subject deals with assessing the sugar to acid ratio through harvesting tomatoes as trusses in different sizes, from small green tomatoes, to mature green, breaker and red tomatoes. We would like to manipulate the sugar to acid (and back: gluconeogenesis) by adding specific substrates and enzyme inhibitors that affect gluconeogenesis and use temperature treatments. Temperature treatments will affect the rate of the two processes under study: glycolysis and gluconeogenesis with the aim to quantify the importance of both processes for different cultivars. We will use the biopsy technique to extract tomato tissue from the same tomato over time to study the dynamics of the sugar and acids levels using HPLC. Studies in different tomato cultivars will give insight why some tomatoes are getting less tasty after harvest, and why some can be stored for longer times without losing the required sugar to acid ration needed for consumer satisfaction.

BSc/MSc and ECTS:  
MSc-thesis: 24-36 ECTS

Type of work:  
Crops: tomato  
Measurements: biopsy sampling, HPLC.

Planning:  
In consultation with the supervisor(s)
Assessment of the effects of “Chilling Injury” on juiciness/mealiness in tomato

Supervisor(s):
Dr. Rob Schouten and dr. Julian Verdonk

Description:
Cold storage of tomatoes in the fridge can affect the juiciness of tomatoes through “Chilling injury”. Juiciness is an important quality attribute for tomato and is the juice extracted when compressed slightly. Juiciness is hard to measure due to biological variation: between tomatoes (tomatoes differ in ripeness) and within tomatoes (the outside layer and the gel part). That means trends are hard to see, and hard to understand when you use conventional measurements. We have come up with a (semi-)non-destructive method that allows us to see how juiciness in the same tomato changes over time: a biopsy needle. We can take tissue out of a tomato without truly damaging it. You would need to develop for instance a high speed centrifugation method to assess the juiciness in biopsy samples. In addition we will investigate the sugar and acid levels of the extracted juice and compared it with the totally extractable juice. Is the juice composed the same, or are there also differences in metabolites? Is a mealy tomato also less tasty? Finally, we will investigate gene expression of cell wall genes and other gene candidate that we suspect are involved with flavor and acidity. Basically, we will split the biopsy sample in three parts to determine juiciness, sugar and acid levels, and gene expression. What will be the influence of especially chilling temperatures, ethylene and 1-MCP? Quantifying mealiness is the first step of identifying less susceptible cultivars and treatments that are resulting in less chilling injury symptoms.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Crops: tomato
Measurements: juiciness measurements (partly to be developed), biopsy sampling, firmness and colour, Gene expression analysis. Because of the workload, this work is preferably done with two students. Alternatively, a selection of preferred experiments and techniques that you want to use can be made.

Planning:
In consultation with the supervisor(s)
Mango taste: sugar metabolism

Supervisor(s):
Dr. Rob Schouten

Description:
Next to firmness, taste is a very important quality attribute for tropical fruits such as mango. This MSc thesis subject deals with answering a simple question: why are mature mangoes so sweet? Mangoes show high respiration (sugar burning) and, therefore, should show a marked decrease in sugar levels especially when starch reserves are quickly depleted during ripening. This appears not to be the case which might point to considerable acid to glucose cycling (gluconeogenesis) as to replenish the sugars.

Is it possible to quantify the sugar metabolism? We will use the biopsy technique to extract tissue from the same mango over time and measure sugars and acids by HPLC analysis. The role of gluconeogenesis will be studied using enzyme inhibitors and feeding of specific substrates. This research may help get insights on the importance of this process for taste development and taste retention in fruits.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Crops: mango
Measurements: biopsy sampling, HPLC, respiration.

Planning:
Flexible starting time.
Mango: Flavour, volatiles and firmness

Supervisor(s):
Dr. Julian Verdonk and Dr. Rob Schouten

Description:
Mangoes have an optimal quality during ripening from very firm (stone hard) to ready to eat mangoes. Mangoes have high respiration rates where sugars and starch are used for production of, amongst others, volatiles. Do mangoes with a high starch (dry matter) content produce different types of volatiles? After reaching the ready to eat stage production (and emission) of so-called off flavours starts, which decrease the quality of the fruit. Can low starch mangoes produce off flavours?

We want to study the development of volatile production in a ripening mango, and follow the emission of VOCs during ripening. What will be the effect of (chemical) fermentation blockers on the volatiles profile? Volatile profiles will be measured using tenax tubes and GC-MS.

We will compare mangoes treated with ethylene, 1-MCP (ethylene inhibitor) with untreated mangoes.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Crops: mango
Measurements: Firmness, Volatiles, GC-MS, Colour

Planning:
Flexible starting time.
**Tomato volatiles: to chill or not to chill**  
*This project can be performed in parallel with the 'to chew or not to chew' project*

**Supervisor(s):**  
Dr. Rob Schouten and Dr. Julian Verdonk, in cooperation with prof. dr. Ernst Woltering (FBR)

**Description:**  
We want to investigate the effect of cold storage because most people still store tomatoes in the refrigerator. We will store tomatoes for different times in the cold and see what volatiles are emitted from whole and chewed fruit for compounds related to lipid peroxidation and the carotenoid pathways. We want investigate the effect of cold treatment on the emitted volatiles from tomatoes using destructive volatile measurements (GC-MS) and in parallel, we will investigate the expression of volatile biosynthesis genes of both pathways and try to quantify a kinetic model for volatile production.

**BSc/MSc and ECTS:**  
MSc-thesis: 24-36 ECTS

**Type of work:**  
Crops: tomato  
Measurements: GC-MS, Gene expression.

**Planning:**  
Flexible starting time.
Tomato volatiles: to chew or not to chew
This project can be performed in parallel with the 'to chill or not to chill' project

Supervisor(s):
Dr. Rob Schouten and Dr. Julian Verdonk, in cooperation with prof. dr. Ernst Woltering (FBR)

Description:
Emitted volatiles from whole fruits can be very different from the ones that are found inside. Most quantifications of volatiles are done on fruits that are cut or crushed and measured hours after. This is not representative for the process of the eating and tasting a tomato, which is done in a much smaller time frame. We have developed a method to simulate the chewing of a tomato (artificial mouth), and measure the emitted volatiles. We will compare the headspace of whole tomato fruits with that of chewed ones, and see which volatiles are responsible for the fruit scent, and which are more important for the flavor we detect during the chewing. Is it possible to estimate the volatile levels in tomatoes by measuring those measured outside the tomato? Can we, in other words, determine the permeability of the skin and calyx (blocked or not) for volatiles?

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Crops: tomato
Measurements: GC-MS.

Planning:
Flexible starting time.
Avocado quality: limiting the effects of bruising

Supervisor(s):
Dr. Rob Schouten and dr. Julian Verdonk, in cooperation with Jan Verschoor (FBR)

Description:
Bruising of avocado is one of the most important quality issues especially later in the chain (e.g. supermarkets). Consumers probing the firmness can induce bruising that result in (brown tissue) within eight hours of touching. Bruising in mainly caused by the PPO enzyme getting into contact with substrates. The PPO enzyme needs oxygen to function.
Can we limit the browning caused by bruising using MAP (Modified Air Packaging)? MAP packaging uses special foils that limit the permeability of oxygen.
We want to start this project using peeled avocados, and later progress to intact avocados. What is the optimal MAP combination of MAP in combination with bruising severity?

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Crops: avocado
Measurements: browning incidence, oxygen levels, PPO activity

Planning:
Flexible starting time.
Stomatal closure and LED treatments during postharvest of strawberries: limiting water loss

Supervisor(s):
Dr. Julian Verdonk and dr. Rob Schouten

Description:
Water loss is one of the main reasons why horticultural produce in supermarkets are more and more shrink wrapped in plastic. It is also known that a number of fruits and vegetables still have functioning and open stomata that are the main channels for water loss. Can we limit water loss by closing stomata of strawberries and LED treatments so that they lose considerably less water? We will be observing the stomatal aperture (openness) using chlorophyll fluorescence and will try to manipulate stomatal aperture using sugar pulsing and ABA (a hormone involved in stomatal opening and closure). Preventing water loss likely also affects health promoting compounds such as ascorbate (vitamin C). Can you find a way to reduce our carbon footprint by eliminating plastic packaging material?

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Crops: strawberries
Measurements: chlorophyll fluorescence, HPLC

Planning:
Flexible starting time.
**NIR spectroscopy and hyperspectral imaging sorting for tomato quality**

**Supervisor(s):**
Dr. Rob Schouten

**Description:**
Hyperspectral imaging is a relatively new tool for fruit quality analysis (e.g. see example description on [http://greenvision.wur.nl/index.php?option=com_content&task=view&id=29&Itemid=51&lang=nl](http://greenvision.wur.nl/index.php?option=com_content&task=view&id=29&Itemid=51&lang=nl)). Hyperspectral imaging enables to quickly scan in the Visible (VIS) and Near Infrared (NIR) part of the spectrum for chemicals connected to health promoting compounds and quality attributes. Hyperspectral imaging can be combined in sorting lines as to grade fruits on e.g. sugar content. This thesis aims to sort tomatoes on sugar content (or brix) using NIR spectroscopy, hyperspectral imaging and HPLC analysis (to estimate the actual sugar content). Is it possible to provide customers with seemingly the same tomatoes that are sorted and priced according to °brix level? Although it is reported that specific peaks in the NIR part of the spectrum are directly related to levels of compounds related to quality attributes, often results in practice are disappointing due to a strong connection between NIR peaks and sugar contents per batch, but not over batches and also not over cultivars.

Is it possible to generate stable calibrations on the basis of NIR spectroscopy for tomatoes of one batch, multiple batches and finally, to test it using hyperspectral imaging? We will use a recently developed technique to manipulate the sugar content in tomatoes by ‘feeding’ the tomatoes with different types of sugars (think e.g. of very sweet green tomatoes). This might generate the large variation needed to catch those peak characteristics that are linked with sugar levels in the NIR spectrum, irrespective of batch or cultivar.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Crops: tomato
Measurements: hyperspectral imaging, NIR, HPLC, multivariate statistics.

**Planning:**
Flexible starting time.
Improvement of lettuce fresh-cut quality

**Supervisor(s):**
Prof. Dr. Ernst Woltering, Maxcence Paillart (MSc - Food & Biobased Research – Wageningen UR)

**Description:**
The shelf life of fresh cut lettuce is limited. In normal air, rapid pink/brown coloration appears due to wound-induced PAL and PPO activities. PAL is responsible for production of intermediates that are converted to colored compounds by PPO. Therefore these products are packed under very low oxygen (near zero %). This blocks PPO activity but not PAL activity. As soon as the bag is opened, PPO becomes active again and the pre-formed intermediates are rapidly converted to brown pigments. A disadvantage of the low oxygen is that fermentation will take place that stimulates the senescence of the product. When we store under higher oxygen concentration, the senescence will be delayed but the brown coloration will take place which makes the product unattractive for consumers. We are seeking for methods that allow these products to be stored under less stringent oxygen conditions (e.g. 2%) without showing pink/brown coloration.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Crop(s): lettuce
We will test different chemicals and treatments known to affect PAL activity or the activity of other enzymes in the pathway leading to pink/brown compounds. Pinking and Browning will be measured spectrophotometrically, PAL and PPO activities will be measured to verify the activity of the treatments.

**Planning/location:**
Laboratory experiments that can be started in consultation with the supervisors; the exact nature of the experiments may change depending on start time.
Location: Food & Biobased Research – Wageningen UR
Photosynthesis and respiration under low light conditions in fresh-cut lettuce

**Supervisor(s):**
Prof. Dr. Ernst Woltering (also FBR, Dr. Jeremy Harbinson and Dr. Wim van Ieperen.

**Description:**
In fresh cut lettuce stored at low temperature and low light intensity, there is significant sugar accumulation, this greatly improves the shelf life. The light level applied is below the light compensation point for lettuce, which means that the sugar can, in theory, not be produced through photosynthesis. Currently it is not clear where the sugars come from. To solve this mystery we hypothesize that under these specific conditions photosynthetic activity may become more efficient than expected as e.g. the photorespiration may be suppressed or CO2 availability may be improved. The aim of the research will be to determine the photosynthetic efficiency of lettuce leaf pieces under a variety of conditions of low light and low temperatures. This will give insight in the behaviour of the photosynthetic and respiratory systems under these conditions. In addition, the accumulation of carbohydrates (glucose, fructose, sucrose, starch) will be monitored and compared to the photosynthetic activities.

**BSc/MSc and ECTS:**
MSc-thesis: 24-36 ECTS

**Type of work:**
Crop(s): lettuce
Methods: LICOR for measurements of dark respiration and photosynthesis, light response curves; HPLC for measurements of carbohydrates; chlorophyll fluorescence imaging for determination PSII activity; microscopy to study stomata opening.

**Planning:**
Laboratory experiments that can be started in consultation with the supervisors; the exact nature of the experiments may change depending on start time.
Cell wall metabolism in senescing rose flowers

Supervisor(s):
Dr. U. van Meeteren and Prof. Dr. E. J. Woltering

Description:
It seems that during senescence of rose flowers, cell wall break down occurs in the flower petals resulting in specific metabolites. The amount of these metabolites is related to storage temperature and duration and therefore is a good predictor of potential vase life of the flowers.

At the moment it is not known which metabolic pathways are involved in the mentioned production of metabolites. It is also not known if the metabolites are indeed the result of cell wall breakdown.

The main objective of this work will be to understand the metabolic pathway that results in some specific metabolites in senescing rose petals.

BSc/MSc and ECTS:
MSc-thesis: 24-36 ECTS

Type of work:
Measuring enzyme activities and cell wall breakdown products of rose flower petals during senescence. Testing specific inhibitors of potentially involved enzymes.

Planning:
Can be done during the whole year.