## Acknowledgement

UBC’s Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xwməθkwəy̓əm (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on in their culture, history, and traditions from one generation to the next on this site.

## Course Information

Ongoing climate change causes unprecedented challenges for agriculture in Canada and globally. The modern farmer requires advanced knowledge about crop physiology and its application to improve irrigation management. But exactly how much water does a plant need to grow satisfactorily? A very common, yet very difficult question to answer. This undergraduate course will provide an advanced understanding of the physiological mechanisms and applied principles that govern plant-water relations. Crop water requirements will be explored in the context of crop performance and survival. Traditional and cutting-edge techniques will be presented as currently used to monitor plant-water relations under laboratory and field conditions. This conceptual knowledge will provide the foundation for developing precision irrigation practices that promote water savings and sustainable agriculture.

|  |  |  |
| --- | --- | --- |
| **Course Title** | **Course Code Number** | **Credit Value** |
| **Plant-Water Relations for Sustainable Agriculture** | 405 | 3 |

### Prerequisites

One of APBI 210, BIOL210

## Contacts

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| --- | --- | --- | --- |
| **Course Instructor(s)** | **Contact Details** | **Office Location** | **Office Hours** |
| Dr. Thorsten Knipfer | Email: [thorsten.knipfer@ubc.ca](mailto:thorsten.knipfer@ubc.ca)  I will respond to emails within working hours 9am to 5pm Monday to Friday. | MacMillan 321 | By appointment |
| Teaching Assistant: Michael Bilek | Email: [mabilek@mail.ubc.ca](mailto:mabilek@mail.ubc.ca)  I will respond to emails within working hours 9am to 5pm Monday to Friday. | MacMillan 302 | |

## Course Instructor Biographical Statement

I joined the Faculty of Land and Food Systems ‘Applied Biology Program’ in September 2020. As an Assistant Professor in Plant Physiology, my research focuses on plant-water relations, xylem transport function, drought resistance, and sustainable irrigation strategies. I obtained my Diploma in 2007 at the University of Bayreuth, Germany. In 2011, I completed my PhD at University College Dublin, Ireland, elucidating the link between cell, organ and whole-plant water transport function. During my Postdoc at the University of California-Davis, USA, I provided novel insights into xylem function using X-ray computed tomography. As an Assistant Project Scientist at UC Davis, USA, I established a physiological phenotyping platform to determine water requirements of woody perennial crops. I have published more than 30 peer-reviewed articles in high-impact journals.

## Other Instructional Staff

A course TA will assist in course demonstrations, grading and for providing feedback to your questions.

## Course Structure

Lectures will be twice a week and taught synchronously. Each lecture (1.5h) will include interactive breakout sessions comprised of groups of 2-4 students (depending on class size) to facilitate problem-based learning, followed by a Q&A session. A multiple-choice quiz will conclude each lecture and to evaluate individual learning progress. 70% of lectures will focus on ‘Theory and Principles’ and 30% of lectures will focus on interactive ‘Tools and Techniques’ presentations. The course will meet in person.

## Schedule of Topics

|  |  |  |  |
| --- | --- | --- | --- |
| **Week** | **Lecture** | **Date** | **Topic** |
| 1 | 1 | Jan-6 | **1. Introduction to water and agriculture:**  Course overview |
| 2 | Jan-8 | History and current concepts of irrigation |
| 2 | 3 | Jan-13 | Tools and Techniques: Plant water status |
| 4 | Jan-15 | Field trip UBC Totem Field - Irrigation |
| 3 | 5 | Jan-20 | **2. Water and cells:**  Water potential, turgor and crop performance  Recommendation for further reading: Turner (2018) Turgor maintenace by osmotic adjustment: 40 years of progress. Journal of Experimental Botany 69, 3223-3233. |
| 6 | Jan-22 | **3. Soil, water and roots:**  Characteristics of soils and soil water content |
| 4 | 7 | Jan-27 | Root water absorption |
| 8 | Jan-29 | Tools and Techniques: Root hydraulics |
| 5 | 9 | Feb-3 | Root systems |
| 10 | Feb-5 | Plant-based irrigation management  Recommendation for further reading: Shackel (2011) A plant-based approach to deficit irrigation in trees and vines. HortScience 46, 173-177. |
| 6 | 11 | Feb-10 | Q/A session, discussion and review |
|  | Feb-12 | **MIDTERM EXAM** |
| *Feb-19 to 23* | | | *Midterm Break* |
| 7 | 12 | Feb-24 | **4. Long-distance water tranport and transpiration:**  Ascent of sap through xylem  Recommendation for further reading: Tyree and Sperry (1989) Vulnerability of xylem to cavitation and embolism. Annu. Rev. Plant hys. Mol Biol 40, 19-38. |
| 13 | Feb-26 | Guest Lecture Dr. Mina Momayyezi (UC Davis) – 3D insights into leaf anatomy |
| 8 | 14 | March-3 | Evaporation from leaves |
| 15 | March-5 | Stomatal behaviour and stress thresholds |
| 9 | 16 | March-10 | Tools and Techniques: Transpiration and stomatal conductance |
| 17 | March-12 | **5. Agricultural water use:**  Water use efficiency  Recommendation for further reading: Hatfiled and Dold (2019) Water use efficiency: Advances and challenges in a changing climate. Frontiers in Plant Science 10, 103 |
| 10 | 18 | March-17 | Field trip UBC Totem Field – Varieties and Flowering |
| 19 | March-19 | Irrigation scheduling  Recommendation for further reading: Jones (2004) Irrigation scheduling: advantages and pitfalls of plant-based methods, Journal of Experimental Botany, 55, 2427–2436. |
| 11 | 20 | March-24 | Tools and Techniques: Mini-weighing lysimeters (field trip UBC Greenhouses) |
| 21 | March-26 | **Paper discussion**: “High-throughput physiological phenotyping and screening system for the characterization of plant-environment interactions”, Halperin et al. 2017 (Plant Journal) |
| 12 | *22* | *March-31* | **6. Water and fruits:**  Biophysics of fruit development |
| 23 | April-2 | Paper discussion: T.B.D |
| 13 | 24 | April-7 | Q/A session, discussion and review |
|  |  | T.B.D. | **FINAL EXAM** |

## Learning Outcomes

Following completion of this course, students will be able to:

1. Discuss the impact of climate change on agricultural production, yield and crop quality.
2. Review techniques and tools used to monitor plant water status in the laboratory and the field.
3. Evaluate plant anatomical-physiological traits in relation to crop performance.
4. Understand the functional link between root regulation, xylem transport and stomatal behavior.
5. Determine physiological stress thresholds for improving crop management.
6. Apply the water potential concept in the context of irrigation management.

## Learning Activities

Learning activities will include in-person participation in breakout groups for group discussions, problem-based learning, and multiple choice quizzes. Learning activities will be largely in-person. In breakout sessions (15 minutes), you be assigned to a group (2-4 students depending on class size). You will be provided with one problem-solving question that relates to lecture content or required readings. Breakout groups are followed by group discussions (10min). Breakout groups are intended to encourage critical thinking and prepare you for solving/answering questions as they will appear in midterm and final exams. Recommended readings are intended for further study beyong the scope of this course.

## Learning Materials

Material will be provided in the weekly modules on Canvas. This will include links to papers. The course will follow principles as stated in the following books:

-Kramer and Boyer, Water Relations of Plants and Soil (Academic Press)

-Park Nobel, Physiochemical and Environmental Plant Physiology (Academic Press)

Internet and laptop access is recommended in-class. Upon request, access to computers can be obtained through UBC Learning Center. Access to lecture content will be provided on Canvas.

## Assessments of Learning

Assessment will be based on successfully participation and quality of your asignments

**Distribution of Marks**

* Course attendance 10%
* Multiple choice quizzes 30%
* Midterm exam 30%
* Final exam 30%

Total 100%

**Summary of Assessments of Learning**

Course attendance: In-person presence is required for successful completion of the course. You will receive a 1-point attendance score per session.

Multiple choice quiz:A four question multiple-choice quiz relating to the lecture content (and required readings) will be given to you 10 min before the end of each class. You have until 11:59pm the same day to complete the online quiz. The quiz will be accessible on Canvas. The goal of this quiz is to evaluate your learning progress.

Midterm and Final Exams:Questions for midterm and final exams will be multiple choice (in total 40) based on lecture content. Questions are similar in style as during weekly multiple choice quizzes. The final exam will focus on lecture content after the midterm. Exams will focus on conceptual knowledge, problem solving and critical thinking.

## COURSE Policies

The course will provide an inclusive environment where everybody is treated fairly and is equally respected regardless of ethnic or cultural background. The course requires in-person presence in the classroom. Under special circumstances, I reserve the right to move a lecture to online only or cancel (e.g. snow chaos, bus strike, sickness), which will be communicated prior to class via Canvas. **Excused absence (course attendace, exams) is limited to:**

* Illness (including mental or behavioral health).
* Family emergency, death in the immediate family.
* Observance of a religious holiday or event.
* Situations beyond the control of the student.

If so, please inform me by email including your official reason of absence for me to review and for my records.

### Learning Analytics

The course will use Canvas to obtain information on learning activities. Learning resources are available through Student Services, <https://students.ubc.ca/enrolment/academic-learning-resources>.

### Copyright

All materials of this course (course handouts, lecture slides, assessments, course readings, etc.) are the intellectual property of the Course Instructor or licensed to be used in this course by the copyright owner. Redistribution of these materials by any means without permission of the copyright holder(s) constitutes a breach of copyright and may lead to academic discipline. Students are permitted to record the class.