

The University of Manitoba
Faculty of Agricultural and Food Sciences



Course Title: Physiology of Crop Plants

Department: Plant Science

Course Number: PLNT 4590

Academic Session: Winter 2011

Credit Hours: 3

Prerequisites and How They Apply to This Course: CHEM 2770/2360: provides basic concepts of biochemistry including the properties of biomolecules (amino acids, proteins, enzymes, carbohydrates, lipids and nucleic acids) and aspects of energy production in cells; PLNT 3500 or BIOL 2242/3450: provides an integrative view of major physiological processes in plants, spanning the biochemical, cellular, tissue, organ and whole plant levels of organization and addressing the effects of environmental conditions on these processes. Moreover, basic knowledge in crop science and soil science is desirable.

Lecture Hours: 12:30 - 1:20 pm (MWF)

Location: Room 134, Agriculture Building

Laboratory Hours: 2:30 - 5:25 pm (W)

Location: Room 342, Agriculture Building

Department Office Location: 222 Agriculture Building

Instructor Information

Instructor: Dr. Belay Ayele (I prefer to be addressed as “Belay”)

Office Location: Room 111 Agriculture Building

Research Lab Location: Room 112, Crop Technology Center, 194 Dafoe Road

Office Phone Number: 474-8227

Email Address: b_ayele@umanitoba.ca

Office Hours: 11:00 - 12:30 pm (Thursdays); otherwise, available by appointment only. I can be reached preferably by email, and will reply to your emails within 24 hours.

Lab Demonstrator: Ms. Chelsea Clague

Office Location: 148 Agriculture Building

Office Phone Number: 474-6073

Email Address: umclague@cc.umanitoba.ca

Office Hours: 9:00 - 11:00 am (Mondays)

Course Philosophy

Students' Learning Responsibilities

Students are expected to attend all classes, laboratories or other class meetings officially designated for the course. They are also expected to arrive in good time for all these meetings. Students will read the text book and other assigned materials, and complete all assignments, lab reports and examinations. It is essential that students actively engage in class discussions (e.g. actively listening, posing and responding to questions) and group efforts. All students are expected to abide by the principles of academic honesty and maintain the utmost level of academic integrity.

Why This Course is Useful?

This course is designed to help students integrate and better understand crop growth, development and yield from a perspective of whole plant physiology. In this course, students will gain an overview of crop physiological processes that are necessary to understand how plants operate, and interact with their environment. The course is useful to understand and interpret agronomic phenomena contributing to crop yield. It also offers an opportunity to survey contemporary aspects of crop physiology with emphasis on recent research progress in related fields.

Who Should Take This Course?

This course has considerable value to students in the field of agricultural science including agronomy, crop management, plant breeding and plant biotechnology. As it extensively covers theoretical and practical aspects of crop physiological processes and crop-environment interaction, the course is also of interest for students of applied ecology and environmental science.

How This Course Fits into The Curriculum?

Crop physiology is an integrative course that builds on and applies the conceptual and technical information presented in the foundation courses from a variety of disciplines including plant physiology, crop production, soil science, botany and ecology to further enhance students' capabilities to bear on problems of yield improvement and crop management, and undertake graduate studies in preparation for advanced research and teaching positions.

Course Description/Objectives

Undergraduate Calendar Description: Concepts dealing with the physiological response of crop plants to the environment from the time of seed germination through to reproduction.

Instructional Methods: This course will consist of lectures (with the aid of PowerPoint presentations) and obligatory laboratory work. The lectures are designed to orient students with the conceptual information in the text and current topics in the subject. At the beginning of each class, you will be provided with copies of the PowerPoint slides for each lecture. You are also expected to take notes during the class. The laboratory part of the course will provide hands-on opportunities in structured labs and independent investigations. We will have a total of six lab sessions. You will receive lab handouts at least a week prior to the date of performing the scheduled experiment. At the start of each lab session, the lab demonstrator will give you instructions and background information for the concepts to be illustrated.

General Course Objectives: The aim of this course is to give students a greater understanding of the physiological processes, plant responses and environmental factors affecting growth and productivity of the agricultural crops we depend on, and to stimulate students' learning of basic concepts in crop growth and development. The course is also designed to enable students to use the knowledge of crop physiology to answer practical questions. Basic concepts underlying crop physiology will be demonstrated through laboratory exercises. Specific objectives of this course will be to:

1. Describe in detail the physiology and biochemistry of crop seed germination and dormancy;
2. Examine the physiological aspects of crop growth and phenological development;
3. Define and analyze the mechanisms by which crop plants acquire and utilize resources like carbon, water, light and mineral nutrients;

4. Discuss the concepts of assimilate translocation and partitioning in a crop plant;
5. Examine the physiology of crop adaptation to their environment;
6. Review the physiological basis for crop production and management practices; and
7. Develop critical thinking and problem solving skills with respect to crop physiology.

Learning Outcomes: On completion of the course students should be able to:

1. Distinguish key physiological processes underlying the formation of seedlings from seed embryos;
2. Identify the physiological factors that regulate growth and developmental processes of crop plants, and clearly define their roles;
3. Evaluate the different strategies used by plants to acquire and utilize resources, and formulate a logical argument of their impact on crop productivity;
4. Recognize the significance of assimilate translocation and patterns of its partitioning in determining crop yield;
5. Demonstrate clear understanding of crop-environment interaction and its implication on crop growth and yield;
6. Relate crop physiological processes with agronomic practices used in crop production systems; and
7. Integrate and apply their knowledge of crop physiology for analytical thinking and solving practical problems experienced in agricultural systems.

Description of Examinations

There will be two one-hour mid-term exams and a final comprehensive exam. The mid-term exams will cover mainly the lectures and reading materials covered prior to each exam, whereas for the final exam you should expect the coverage of some cumulative information garnered throughout the term. All the exams are designed to evaluate how well you have achieved the learning outcomes of the course, and will consist of a mixture of questions in fill-in-the-blank, short answer, and essay formats. Planned mid-term exam dates are indicated in the "important dates" section (see below), and are very unlikely to change.

Description of Assignments

A series of five "practical problem solving assignments" will be given during the term. Each assignment will consist of two short questions designed to apply what you have learned in class to practical "real life" situations experienced in agricultural systems. These are intended to make students think and solve practical problems using their knowledge of crop physiology.

Description of Lab Reports

Your lab grade will be determined by your lab reports. The lab reports should have the following sections:

1. **Title Page** - Include the title of the experiment, your name, course name and number, and date of the experiment;
2. **Introduction** - Include brief background information, the purpose and hypothesis of your experiment;
3. **Materials and Methods** - Describe the materials and experimental procedures or methods used in your experiment;
4. **Results** - Show your data or observation in graphical or tabular format and describe it in words. You must also include additional notes you made during the lab;
5. **Discussion and Conclusion** - Discuss and interpret your results, state if the results support your hypothesis, include any errors and suggestions for improvement, and summarize your experiment; and

6. **Citation** - list all the references (books, articles, lab manuals, relevant websites) you have used at the end of the report. Follow the American Psychological Association (APA) citation style.

Assignment and Lab Report due Dates and Places

Assignments and lab reports are due in a week after posting and completion of the lab work, respectively. Assignments are due in the class, whereas lab reports are due in the lab.

Grade Evaluation

Exams, assignments and lab reports will be returned to you after they are marked or graded, except for the final exam. I try to get all your work graded and give you feedback within 10 working days after submission/completion.

Your final grade will be determined by the following:

| | |
|--|-------------|
| Mid-Term Exam 1: one hour examination | 20% |
| Mid-Term Exam 2: one hour examination | 20% |
| Final Exam: one and a half hours final examination | 30% |
| Practical Assignments | 10% |
| Lab Reports | 20% |
| Total | 100% |

Grading Scale

| Letter Grade | Numerical Scale | Letter Grade | Numerical Scale | Letter Grade | Numerical Scale |
|--------------|-----------------|--------------|-----------------|--------------|-----------------|
| A+ | ≥90 % | B | 70-74 % | D | 50-56 % |
| A | 80-89 % | C+ | 65-69 % | F | < 50 % |
| B+ | 75-79 % | C | 57-64 % | | |

Important Dates

| | |
|---------------------------|----------------|
| First Day of Class | January 5 |
| Mid-Term Exam 1 | February 4 |
| Mid-Term Break | February 21-25 |
| Mid-Term Exam 2 | March 4 |
| Voluntary Withdrawal Date | March 18 |
| Last Day of Class | April 8 |
| Final Exam | TBA |

Texts, Readings, Materials

Required Textbook

Taiz L and Zeiger E (2010) Plant Physiology. 5th ed. Sinauer Associates, Inc. Publishers, Sunderland, MA ISBN: 978-0-87893-866-7. It is available at the book store.

Supplementary Reading

Though the text book provides reasonable coverage for most of the topics in the course, it is not either sufficiently detailed or does not cover some of the topics to be discussed in this course. To supplement the shortfalls, please refer to selected chapters from the following books, a copy of which will be held in reserve at the William R. Newman (Agriculture) library.

Bewley JD and Black M (1994) Seeds: Physiology of Development and Germination. 2nd ed. Plenum Press, New York.

Hay R and Porter J (2006) The Physiology of Crop Yield. 2nd ed. Blackwell Publishing Ltd, Oxford, UK.

Additional Materials

Supplementary reading materials will be posted on JUMP website (<https://jump.umanitoba.ca/cp/login/>), and you will be notified of any updates by email from your instructor.

Course Policies

Lecture Class

Most important course materials are discussed in the lecture, thus successful completion of this course requires that students attend all classes. Missing a class will make understanding of materials presented in subsequent sessions difficult. Your class participation will be critical in swaying my decision in borderline grading situations.

Please note that disruptive behaviors including use of cell phones, texting, talking to others and reading unrelated materials during the class will not be tolerated, and students engaged in such behaviors will be asked to leave the class.

Lab Attendance

Lab attendance and participation is mandatory. Reports will not be accepted if the lab is not attended, unless the student provides acceptable justification and/or documentation as required. Note that the laboratory section of the course must be passed to pass the course.

Late Assignments and Lab Reports

Assignments and lab reports not submitted by the due date will be penalized 10% of the total value for each day late.

Missed Assignments and Lab Reports

Missed assignments will receive a zero grade. If a lab report is missed, an “I” (for incomplete) grade will be assigned to the student.

Early and Missed Examinations

Exams must be written on the scheduled dates. No early exams will be given. A student who misses a mid-term exam will automatically receive a grade of zero for that exam. If a final examination is missed, an “F” grade will be assigned to the student. Only students with legitimate excuses/documentation deemed acceptable will be allowed to make up missed exams.

Academic Integrity

Plagiarism or any other form of cheating in examinations, term tests or academic work is subject to serious academic penalty. Cheating in examinations or tests may take the form of copying from another student or bringing unauthorized materials into the exam room. Exam cheating can also include exam impersonation. A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty. Students should acquaint themselves with the University’s policy on plagiarism; cheating, exam impersonation and duplicate submission (see Section 8, page 27 in the University of Manitoba Undergraduate Calendar 2010/11).

Persons with Special Needs: Please feel free to contact me at the very beginning of the term if you have any concerns or learning needs.

Additional Comments

Evaluative feedback from the first assignment and midterm examination will be provided prior to the deadline for voluntary withdrawal (see important dates above).

Use of Third Party Detection and Submission Tools

Electronic detection tools may be used to screen assignments in cases of suspected plagiarism.

Group Work Policies

Regardless of how each lab work is performed (individually or in group); lab reports should be written on an individual basis.

Course Content

| <u>Topics</u> | <u>Lecture Weeks (# of lectures)</u> |
|--|---|
| 1. Seed Physiology <ul style="list-style-type: none"> - Seed structure and its composition - Seed storage reserves: the energy to fuel early seedling growth - Seed imbibition and germination: the transition of seed embryo into a seedling - Metabolic and cellular events during germination - Physiology of seed dormancy: deciding to germinate or not to germinate - Mobilization of storage reserves and its control | Week 1-3 (6 lectures) |
| 2. Crop growth and phenological development <ul style="list-style-type: none"> - Seedling emergence: phasing out dependence on storage reserves - The role of cell division in crop development - Cell walls and elongation: plant tissues plasticity and elasticity - Root formation, development and its regulation - Shoot formation and its development | Week 3-4 (5 lectures) |
| 3. Crop canopy, photosynthesis and respiration <ul style="list-style-type: none"> - The life history of a leaf: why it is important? - Components of plant leaf area expansion - Leaf anatomy and its role in light interception - The development of crop canopy: leaf area index - Canopy architecture and light penetration - Photosynthesis and photorespiration - Photosynthetic response to temperature and CO₂: the greenhouse effect - Crop respiration at the field, crop and canopy level | Week 5-7 (7 lectures) <i>Feb.4 = 1st Mid-Term Exam</i> |
| Week 8 (February 21-25) Mid-Term Break: No Classes | |
| 4. Mineral nutrition of crops <ul style="list-style-type: none"> - Essential nutrients and crop growth response - Nitrogen assimilation - Biological nitrogen fixation and its regulation - Phosphate assimilation | Week 7& 9-10 (4 lectures) <i>Mar.4 = 2nd Mid-Term Exam</i> |

| <u>Topics</u> | <u>Lecture Weeks (# of lectures)</u> |
|--|---|
| 5. The physiology of flowering in crop plants <ul style="list-style-type: none"> - Floral meristems and floral organ development - Floral evocation: the endogenous and exogenous cues - Biochemical signaling involved in crop flowering | Week 10-11 (4 lectures) |
| 6. Seed development and pre- and post-harvest physiology <ul style="list-style-type: none"> - Embryogenesis and seed formation: the making of next generation plants - Assimilate translocation: pathways and patterns - Assimilate partitioning and remobilization: source-sink interaction - Deposition of storage reserves, seed maturation and desiccation - Physiology of pre-harvest sprouting: why seeds germinate on the parent plant? - Seed storage and seed longevity: what is wrong with aged seeds? | Week 11-13 (5 lectures) |
| 7. Crop stress physiology <ul style="list-style-type: none"> - Water deficit and drought tolerance - Salinity stress: the salt injury - Temperature stress: the heat, the chill and the freeze - Flooding and hypoxic stress: the suffocation of plant tissues | Week 13-14 (5 lectures) |

* Lecture dates may change