

INTERNATIONAL SEED PHYSIOLOGY

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Horticulture and Crop Science 631

312B Kottman, 292-9003

**SYLLABUS**  
**Spring, 2008**

**I. RECOMMENDED TEXT:** *Seed Development, Dormancy and Germination* (eds. K. J. Bradford and H. Nonogonki), Blackwell Publishing, 2007, 392 pp.

**OTHER READINGS:**

McDonald, M. B. 2000. Seed priming. In: *Seed Technology and Its Biological Basis* (eds. M. Black and J. D. Bewley). Plenum Press, New York.

McDonald, M. B. 1999. Seed deterioration: Physiology, repair and assessment. *Seed Sci. & Technol.* 27:177-237.

McDonald, M. B. 1994. Seed germination and seedling establishment. Pp. 37-60. In *Physiology and Determination of Crop Yield* (eds. K. J. Boote, J. M. Bennett, T. R. Sinclair, and G. M. Paulsen). Crop Sci. Soc. Amer., Madison, WI.  
ETC.

**II. CLASS SCHEDULE:**                      Lecture                      T R                      9:00 – 10:30                      333D KH

**III. GRADE DISTRIBUTION**                      Mid-term (May 1)                      50%  
Final (May 29)                      50%

**IV. HOLIDAYS**                                      None

**V. COURSE SYLLABUS**

**General Objectives**

The student will be able to:

1. Gain a greater understanding of seed physiology in agronomic, turf, vegetable, landscape, and ornamental seed crops.
2. Describe the physiological and morphological processes of seed development as modified by the environment from anthesis to maturity.
3. Apply the principles of biochemistry and physiology to the processes controlling seed development, maturation, germination, dormancy, and deterioration.
4. Identify the ecophysiological aspects of seeds regulating germination in differing environments.
5. Describe the factors controlling the mobilization of stored reserves during germination.
6. List the factors governing the longevity of agricultural seeds as they affect seed viability.

**Lecture Organization and Content**

International Seed Physiology – HCS631  
Calendar Spring 2008

Course Syllabus

Day	Class	
Thursday, 3/27	Introduction	Julio M- ESALQ
Tuesday, 4/1	Seed Formation	Samuel C- PUC
Thursday, 4/3	Seed Development (maturation)	Julio M- ESALQ
Tuesday, 4/8	Seed Germination I	Miller M- OSU
Thursday, 4/10	Seed Germination II	Mark B- OSU

Thursday, 4/15	Water relations on Seeds	Julio M- ESALQ
Tuesday, 4/17	The Chemistry of Seeds	Samuel C- PUC
Tuesday, 4/22	Seed Dormancy	Samuel C- PUC
Thursday, 4/24	Seed Deterioration I	Miller M- OSU
Tuesday, 4/29	Seed Deterioration II	Miller M- OSU
Thursday, 5/1	MID TERM EXAM	
Tuesday, 5/6	Seed Enhancements	Mark B- OSU
Thursday, 5/8	Recalcitrant Seeds	Julio M- ESALQ
Tuesday, 5/13	Germination and Biodiversity of Native Grasses	Hwei-Yiing J- LU
Thursday, 5/15	Vigor and Seed Performance	Mark B - OSU
Tuesday, 5/20	Evaluation of Seed Physiological Potential	Ana N - ESALQ
Thursday, 5/22	Paper review	
Tuesday, 5/27	Seed Biotechnology	Kent B- UC Davis
Thursday, 5/29	FINAL EXAM	

Tuesday, OSU (Columbus & Wooster) – ESALQ –Lincoln sessions via Polycom

Thursday, OSU (Columbus & Wooster) sessions

### International Seed Science and Technology Graduate Program

#### Course Content

**Schedule:** 17 modules of ± 90 minutes (25 h)

#### I. INTRODUCTION

1. Importance of Seeds
  - 1.1. Seeds for survival and subsistence
  - 1.2. Direct or indirect source of food, industry and essential products
  - 1.3. Plant propagation
  - 1.4. Plant breeding
  - 1.5. Agriculture
2. Seed Physiology
  - 2.1. General concepts: plant biology x seed technology
  - 2.2. Historical outlines

#### II. SEED FORMATION

1. Floral Induction and Initiation
  - 1.1. Water
  - 1.2. Temperature
  - 1.3. Photoperiod
  - 1.4. Soil fertility and plant nutritional status
  - 1.5. Chemical stimuli
2. Floral morphology
3. Pollen and ovule formation (microsporogenesis and megasporogenesis)
4. Pollination and fertilization
  - 4.1. Types and agents of pollination
  - 4.2. Importance for seed production and quality
  - 4.3. Relevant aspects of plant pollination on vegetable and grain crops hybrid seed production
5. Embryogeny and embryo development
  - 5.1. Monocotyledonous
  - 5.2. Dicotyledonous
6. Endosperm and perisperm development
7. Seed coats
  - 7.1. General structure
  - 7.2. Functions
8. Fruit development

9. Seed structure
10. Apomixis and polyembryony

### III. SEED DEVELOPMENT (Maturation)

1. Concepts of seed maturation
2. Stages of seed development
3. General parameters to characterize seed maturation
4. Reserve accumulation
5. Seed physiological maturity and harvesting time
6. Environmental factors affecting seed development
7. Metabolism reversion from development to germination
8. Desiccation tolerance

### IV. THE CHEMISTRY OF SEEDS

1. Importance
2. Carbohydrate storage in seeds
3. Lipid storage in seeds
4. Protein storage in seeds
5. Other chemical compounds found in seeds
6. Factors affecting chemical composition of seeds
  - 6.1. Genotype
  - 6.2. Seed position within the plant and inflorescence
  - 6.3. Climate
  - 6.4. Seed maturation
  - 6.5. Soil fertility and plant nutrition
  - 6.7. Crop management
7. Relationship of chemical composition, hygroscopic equilibrium and seed storability

### V. WATER RELATIONS ON SEEDS

1. Functions of Water in Seeds
2. Seed Moisture Content
3. Hygroscopic equilibrium and seed water potential
4. Water Status in Seeds
5. Physiological Events Associated to Seed Water Status and Moisture Content

### VI. SEED GERMINATION (2 sessions)

1. The Germination Concept: Plant Biology x Seed Technology Approaches
2. The Germination Process
  - 2.1. Imbibition
  - 2.2. Respiration
  - 2.3. Enzyme Activation and Mobilization of Stored Reserves
  - 2.4. Metabolites Transport and Assimilation
  - 2.5. Primary Root Protrusion and Seedling Growth
3. Factors Affecting Seed Germination
  - 3.1. Internal
    - a) Seed vitality
    - b) Genotype
    - c) Seed maturation
    - d) Seed dormancy
  - 3.2. Environmental factors
    - a) Water
    - b) Temperature
    - c) Oxygen
    - d) Light
  - 3.3. Chemical promotion of seed germination

- a) Endogenous hormones
  - b) Hydrogen peroxide
  - c) Potassium nitrate
  - d) Other chemical compounds
- 3.4. Other factors
- 3.5. Stress responses

## VII. SEED DORMANCY

1. Definition
2. Significance of Dormancy: biological function x seed technology approaches
3. Primary and Secondary Dormancy
4. Factors that Control the Induction of Dormancy
5. Causes of Dormancy
6. Methods to Overcome Dormancy

## VIII. SEED DETERIORATION (2 sessions)

1. The Life Span of Seeds
2. The Concept of Seed Deterioration
3. Physiological Changes During Seed Deterioration
4. Biochemical Changes During Seed Deterioration
  - 4.1. Respiration and ATP synthesis
  - 4.2. Synthesis and activity of enzymes
  - 4.3. Depletion of food reserves: carbohydrates, lipids and proteins
  - 4.4. Genetic degradation
  - 4.5. Membrane structure and permeability
5. General Pattern (sequence) of Seed Deterioration
6. The Glassy State
7. Factors Affecting Seed Deterioration
  - 7.1. Seed Physiological Potential
  - 7.2. Environmental conditions during seed development
  - 7.3. Harvesting time and management
  - 7.4. Seed artificial drying
  - 7.5. Seed processing
  - 7.6. Seed storage conditions
  - 7.7. Seed packaging
  - 7.8. Seed treatment
  - 7.9. Mechanical damage
  - 7.10. Insects and microorganisms

## IX. SEED ENHANCEMENTS

1. Concept
2. Priming Technology
  - 2.1. Hydroconditioning
  - 2.2. Matricconditioning
  - 2.3. Osmoconditioning
  - 2.4. Biopriming
3. Effects of priming
4. Factors affecting seed performance (post-treatment effects)
5. Seed coating techniques
  - 5.1. Pelleting
  - 5.2. Coating

## X. RECALCITRANT SEEDS

1. The recalcitrance concept
2. General characteristics of Recalcitrant Seeds

- 2.1. Seed morphology
- 2.2. Seed development and maturation
- 2.3. Categories of recalcitrant seeds
- 3. Desiccation Tolerance
  - 3.1. Concept
  - 3.3. Water relations
  - 3.4. Intracellular characteristics
  - 3.5. Metabolical activity
  - 3.7. Protecting compounds
  - 3.8. Drying rate
- 4. Association to microorganisms
- 5. Storage of recalcitrant seeds

## XI. EVALUATION OF SEED PHYSIOLOGICAL POTENTIAL

- 1. Importance
- 2. The Germination Test
- 3. The Tetrazolium Test
- 4. Recommended Vigor Tests
  - 4.1. Accelerated Aging
  - 4.2. Cold Test
  - 4.3. Electrical Conductivity Test
  - 4.4. Seedling Growth Tests

## XII. VIGOR AND SEED PERFORMANCE

- 1. Seed quality attributes
- 2. Significance of Physiological Potential and Seed Vigor
- 3. The Definition (or concepts ?) of seed vigor
- 4. Factors Affecting Seed Vigor
- 5. Relationship of vigor and seed performance
  - 5.1. Seedling emergence and initial development
  - 5.2. Plant development and yield
    - a) Grain crops
    - b) Vegetable crops
- 6. Concluding remarks

VII. **ACADEMIC MISCONDUCT.** Students are trusted to act in good faith in exams, laboratory projects, and essays. If it is determined that students have breached that trust, they will be reported to the appropriate channels to the University Committee on Academic Misconduct. The OSU Student Handbook thoroughly covers the subject of academic misconduct and its treatment, if students require further information. Academic misconduct will not be tolerated.

VIII. **DISABILITY ACCOMODATIONS.** Students with chronic disabilities are encouraged to inform the instructor before or immediately at the start of the term. The instructor will work with the student and the Office of Disability Services to provide appropriate accommodations. No special accommodations will be made for students who do not inform the instructor in a timely fashion, or who do not involve the Office of Disability Services. Temporary disabilities will be accommodated at the instructor's discretion.

## TERM PAPER REQUIREMENTS

The term paper consists of 40% of your final grade and is, therefore, an important part of the course. The term paper topic is left to your discretion but must be associated with some physiological trait and its relationship with seeds. For example, you may be interested in the influence of water relations and their effect on seed imbibition that affects the rate of seed emergence. Another topic might be the relationships of seed pathogens during seed storage and their effect on seed quality. These are only examples and the choice of topic is yours. If you are not certain about the applicability of the subject, do not hesitate to contact me.

An important requirement of the term paper is that there must be at least three papers cited from the 2005 literature. The term paper **is not** intended to be a literature review. Rather, you must take at least three recent scientific articles and integrate their most important findings into a unified understanding of the physiological mechanisms of seed performance. You may use more references if you wish, but the three recent articles must be the “centerpiece” of the paper. The term paper should be approximately 10 to 15 pages in length, double-spaced, and typewritten. It should include the following divisions:

- I. **Introduction** - 1 to 2 pages in length. This section introduces the importance of the topic, what has been found to date, and what the stated objective(s) of this report is.
- II. **Results** - 3 to 4 pages in length. Present the important results from the three 2001 articles in this section. You can simply photocopy either Tables or Figures from the articles and tape them into the report. Ensure during your presentation of the results that you emphasize what findings are important. If a discussion of the procedures and Materials and Methods is relevant, place it in this section. Make sure to **not discuss** the results but only present the essential findings.
- III. **Discussion** - 4 to 5 pages in length. This is the most important part of the term paper! Here, you must be able to interpret the significance of the research findings as well as tie the separate research papers into a unified concept. Keep in mind the objective(s) listed in the Introduction. Has it been satisfied following your discussion? Since you are considering recent research advances, you should be developing new concepts relating to physiological mechanisms and seed performance. It is appropriate to use previous studies to support your arguments should you so desire.
- IV. **Conclusions** - ½ to 1 page. In a succinct way, identify the important conclusions developed from your study as well as the future direction of research efforts to expand knowledge.
- V. **Literature Cited** - Make sure to cite the literature referenced in your report.

If handled properly, this term paper requirement can be a meaningful and learning experience. If I can be of any assistance as you develop it, do not hesitate to contact me. Keep in mind that the term paper is due December 1. A general history of success reveals that the best term papers are started early in the quarter. **DON'T WAIT TILL THE LAST MINUTE! START NOW.**