

## **AGR 6322 Advanced Plant Breeding (Sections 22382 and 28350)**

Graduate Level – 3 credit hours

Fall 2024

### **Instructors:**

Dr. Esteban Rios

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352-294-3795

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Office Hours: TBD. Please feel free to talk to me about any issue relating to the course, and start this process early in the semester.

**Lecture time:** Tuesdays period 4 and 3 (10:40 – 11:30); and Thursdays period 3 and 4 (9:35 – 11:30)

**Location:** Agronomy Genetics and Physiology - 2005 SW 23rd St Bldg 344, Gainesville, FL 32608

### **Pre-requisites**

AGR5321 – Genetic Improvement of Plants or equivalent; and STA6166 or equivalent.

### **Course Description**

This course focuses on theoretical and practical application of plant breeding, genetics, and statistics to devise effective methods and approaches to lead a successful breeding program. The course builds upon knowledge of biology, molecular genetics, statistics, plant breeding and quantitative genetic theory to highlight real-life challenges that plant breeders face in their journey to develop improved cultivars. Four specific functional areas, which reflect division of labor and resources in breeding programs are addressed: population development, population evaluation and selection, genomics and phenomics in breeding, and product commercialization and supply.

### **Learning Objectives**

- Students will understand traditional and modern plant breeding concepts, approaches and methods used to develop and release improved cultivars.
- Student will learn how to identify germplasm sources and other methods to create breeding populations.
- Students will estimate population genetic parameters and apply these concepts in plant breeding to maximize the efficiency in creating and managing breeding populations.
- Students will learn the fundamentals of experimental designs and data analysis used in plant breeding.
- Students will develop an understanding of strategies pertaining to genomic breeding and advanced tools used to expedite cultivar improvement.
- Students will comprehend the process of cultivar release and commercialization in plant breeding.
- Students will develop a research proposal addressing a breeding project in their crop of choice.
- Students will develop an appreciation of the role of plant breeding in agriculture and society.

### **Intended Audience**

The course is designed for MS and PhD graduate students in the following disciplines: plant breeding, agronomy, horticultural sciences, environmental horticulture, forestry, and plant molecular and cellular biology.

### **Course Objectives**

This course will demonstrate the application of breeding principles to crop improvement through a review of traditional and modern techniques. The focus of the course is to familiarize students with advanced breeding strategies, methods, and techniques in plant breeding, and how to apply those concepts in breeding programs. This course is designed to complement other plant breeding, quantitative genetics, and statistical genetic courses. At the end of this course, students will be able to distinguish multiple approaches to develop breeding populations, including germplasm acquisition, mating designs, and apply population genetic concepts to manage breeding populations more efficiently. Students will also design and analyze data following experimental designs commonly used in plant breeding trials, particularly to explore genotype by environment interaction. Students will be able to identify novel methods to accelerate crop improvement, including marker assisted selection and genomic

approaches. Finally, students will also be challenged to develop a research proposal for a plant breeding project, including a budget, timeline and resources required to operate a successful plant breeding program.

## Evaluation

### Quizzes

Four quizzes will happen randomly during lectures. They will consist of questions pertinent to the topic being discussed in class. Students are required to email the answer to the instructor during the allotted time period when the quiz is assigned. THERE IS NO MAKE UP OF QUIZZES. Answers for quizzes are reviewed and discussed in class after completion to provide comprehensive feedback.

### Paper Discussion

A peer-reviewed scientific publication will be assigned to each student. Students will lead the discussion for the paper, including tables/graphs/figures presented in the manuscript, as well as using other references if needed. Leading students are expected to prepare six questions that will be presented to the class to encourage participation. Each student will receive one-to-one feedback from instructor after their presentation, and the final grade will combine their own discussion and participation. There is no make-up of discussion grades.

### Breeding Proposal

A Request for Proposals (RFP) will be presented to students: <https://southern.sare.org/Grants/Apply-for-a-Grant/Graduate-Student-Grants/>. Students will work individually to write and present orally their proposed work and budget. Students will receive training on proposal writing, budget preparation and proposal submission by the UF-IFAS Shared Services, and they are expected to follow the RFP for formatting, word limits and budget. The breeding proposal will be divided in three parts:

**Part 1.** Due on Thursday September 26 by 5 PM (EST) in Canvas. It should contain the title, your name and UFID, Statement of Problem, Rationale and Justification (limited to 500 words) and Project Relevance to Sustainable Agriculture (limited to 500 words). Each student will receive feedback from instructor and TA.

**Part 2.** Due on Thursday October 24 by 5 PM (EST) in Canvas. It should include all the sections presented in Part 1, plus an abstract (250 words), objectives (500 words), and approach and methods (1000 words). Each student will receive feedback from instructor and TA.

**Final.** Due on Thursday November 14 by 5 PM (EST) in Canvas. It should include all the sections presented in Part 1 and 2, plus timetable (500 words), literature cited (250 words), budget and budget justification. Each student will receive feedback from instructor and TA.

**Oral presentation.** Each student will present their final project during a 15-minute presentation in class on November 19 and December 3 (students will be assigned to those dates). The presentation format is open and students are encouraged to use their preferred delivery method. It will be presented to the whole class through Zoom and its format should follow the final RFP sections. Each student will receive feedback from instructor and TA.

### Exam

There will be a final take-home exam on November 21 during normal class time (9:35 to 11:30 AM).

Activity	Number	Points/activity	Total
Quizzes	4	2.5	10
Paper Discussion	1	20	20
Breeding Proposal – Written	1	20	20
Breeding Proposal – Oral	1	20	20
Final Take-home Exam	1	30	30

A >91    B+ 85 to 90    B 80 to 84    C+ 75 to 79    C 70 to 74    D+ 65 to 69    D 60 to 64    E < 60

UF grading policies: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>.

### Software and computer

**You will need to use your own laptop for data analyses demos and homework.** Different software will be used during the semester. Specific instruction where and how to obtain them will be given in class.

### Recommended Literature – specific scientific papers will be assigned as the semester progresses

D.L. Hartle & A.G. Clark – *Principles of Population Genetics*, Fourth Edition. 2006.

D.S. Falconer – *Introduction to Quantitative Genetics*, 2<sup>nd</sup> edition. 1981.

M.L. Lynch & B. Walsh – *Genetics and Analysis of Quantitative Traits*. 1998

Mrode, R. A. *Linear Models for the Prediction of Animal Breeding Values*. Boston, MA :CABI, 2014. Print.

### Course Schedule and Topics (Tentative)

Week	Description
<b>Area: Population development</b>	
1	Theme: Essentials of Plant Breeding 1: Thursday Aug 22 a. Introductions, reviewing syllabus, and assessment of expectations b. Essentials of Plant Breeding c. Elissar Alam (PhD candidate PB): Success story for a SARE proposal. d. Dr. Mickie Swisher: Justification and Project Relevance to Sustainable Agriculture.
2	Theme: Population Genetics Day 1: Tuesday August 27 a. Population Genetics I  Day 2: Thursday August 29 a. Population Genetics II b. Paper discussion on Population Genetics – Student Leader: TBD c. Breeding schemes: recurrent selection, line development, clonal evaluation
3	Theme: Mating Designs Day 1: Tuesday Sept 3 a. Mating Designs  Day 2: Thursday Sept 5 a. Mating designs and use of pedigree in Plant Breeding – Leader: Dr. Gary Peter b. IFAS Shared Services: writing proposals, budget preparation, and submission.
4	Theme: Breeding polyploid crops Day 1: Tuesday Sept 10 a. Breeding polyploid and apomictic crops I  Day 2: Thursday Sept 12 b. Paper discussion on breeding polyploid crops – Student Leader: TBD c. Breeding polyploid crops – Leader: Dr. Margaret Worthington, Univ. of Arkansas

5	<p>Theme: Quantitative genetics in diploid and polyploid crops</p> <p>Day 1: Tuesday Sept 17</p> <ul style="list-style-type: none"> <li>a. Tools for Polyploid Crops Talk/Discussion. Leader: TBD</li> </ul> <p>Day 2: Thursday Sept 19</p> <ul style="list-style-type: none"> <li>a. Quantitative Genetics. Leader: Dr. Tols for</li> <li>b. Tools for Polyploid Crops Talk/Discussion. Leader: TBD</li> </ul>
<b>Area: Population evaluation</b>	
6	<p>Theme: Experimental Designs in Plant Breeding</p> <p>Day 1: Tuesday Sept 24</p> <ul style="list-style-type: none"> <li>a. Field plot techniques and experimental designs I</li> </ul> <p>Day 2: Thursday Sept 26</p> <ul style="list-style-type: none"> <li>a. Field plot techniques and experimental designs II</li> <li>b. Demo in R for experimental designs. Leader: TBD</li> </ul> <p><b>Breeding Proposal Part 1 Deadline due at 5 PM.</b></p>
7	<p>Theme: Use of BLUP in breeding</p> <p>Day 1: Tuesday Oct 1</p> <ul style="list-style-type: none"> <li>a. Linear Mixed Models</li> </ul> <p>Day 2: Thursday Oct 3</p> <ul style="list-style-type: none"> <li>a. BLUP in plant breeding</li> <li>b. Demo in R for BLUPs and estimating Genetic Parameters.</li> <li>c. Paper discussion on BLUP – Student Leader: TBD</li> </ul>
8	<p>Theme: Genotype by Environment Interactions</p> <p>Day 1: Tuesday Oct 8</p> <ul style="list-style-type: none"> <li>a. Genotype by Environment Interaction. Leader: Dr. Diego Jarquin</li> </ul> <p>Day 2: Thursday Oct 10</p> <ul style="list-style-type: none"> <li>b. Complex models for GxE. Leader: Dr. Diego Jarquin</li> <li>c. Demo for GxE models. Leader: Dr. Diego Jarquin</li> </ul>
<b>Area: Genomics and Phenomics in Breeding</b>	
9	<p>Theme: Use of molecular tools in Plant Breeding</p> <p>Day 1: Tuesday Oct 15</p> <ul style="list-style-type: none"> <li>a. QTL mapping and Marker Assisted Selection. Leader: Pablo Sipowicz.</li> </ul> <p>Day 2: Thursday Oct 17</p> <ul style="list-style-type: none"> <li>b. Paper discussion on QTL and MAS – Student Leader: TBD</li> <li>c. Applying MAS in Breeding. Leader: Dr. Jessica Chitwood-Brown.</li> </ul>
10	<p>Theme: Genomics in Breeding</p> <p>Day 1: Tuesday Oct 22</p> <ul style="list-style-type: none"> <li>a. Genomic breeding I: Genome-wide Association Studies</li> </ul> <p>Day 2: Thursday Oct 24</p> <ul style="list-style-type: none"> <li>b. Genomic Breeding II: Genomic Prediction</li> <li>c. Paper discussion on GWAS – Student Leader: TBD</li> </ul> <p><b>Breeding Proposal Part 2 Deadline due at 5 PM.</b></p>

11	<p>Theme: Genomics in Breeding</p> <p>Day 1: Tuesday Oct 29</p> <p>a. Genomic Breeding III: Genomic Prediction</p> <p>Day 2: Thursday Oct 31</p> <p>a. Paper discussion on Genomic Prediction – Student Leader: TBD</p> <p>b. Demo for Genomic Prediction models. Leader: Dr. Diego Jarquin</p>
12	<p>Theme: Genomics and Phenomics in Breeding</p> <p>Day 1: Tuesday Nov 5</p> <p>a. Genomic Prediction in Allogamous Crops. Leader: TBD.</p> <p>Day 2: Thursday Nov 7</p> <p>a. Genomic Prediction in Autogamous Crops. Leader: TBD.</p> <p>b. Genomic and Phenomic Prediction Deployment in Industry. Leader: TBD.</p>
13	<p><b>NO CLASS Nov 12 due to ASA, CSSA, and SSSA MEETING.</b></p> <p>Day 2: Thursday Nov 14</p> <p>a. Genomic Breeding IV: Transformation and targeted mutagenesis in plant breeding – Leader: Dr. Alfred Huo</p> <p>b. Phenomics in plant breeding – Leader: Dr. Kevin Wang</p> <p><b>Breeding Proposal Final Deadline due at 5 PM on Nov 10.</b></p>
<b>Area: Product Commercialization, Marketing and Supply</b>	
14	<p>Theme: Intellectual Property Protection in Plant Breeding</p> <p>Day 1: Tuesday Nov 19</p> <p>a. IP in Plant Breeding: Cultivar Release and Marketing. Leader: John Beuttenmuller, Florida Foundation Seed Producers Inc.</p> <p>Day 2: Thursday Nov 21</p> <p>a. <b>Take-home Exam during class hours.</b></p>
15	<p>Theme: Proposal Presentations</p> <p>Day 1: Tuesday Nov 26</p> <p>a. <b>No class due to Holidays (Happy Thanksgiving!).</b></p> <p>Day 2: Thursday Nov 28</p> <p>a. <b>No class due to Holidays (Happy Thanksgiving!).</b></p>
16	<p>Theme: Final Exam</p> <p>Day 1: Tuesday Dec 3</p> <p>a. Proposal Presentations: 6 students, 8 minutes each.</p> <p>b. Class wrap-up and feedback</p>

#### ADDITIONAL REFERENCES

- Bernardo, R. 2010. Breeding for Quantitative Traits in Plants. Second Edition. Stemma Press, Minnesota.
- Cameron, N.D. 1997. Selection Indices and Prediction of Genetic Merit in Animal Breeding. CAB International. Wallington, UK.
- Hallauer, A.R.; Carena, M.J. Miranda Filho, J.B. 2010. Quantitative Genetics in Maize Breeding. Springer, New York.
- Henderson, C.R. 1984. Applications of Linear Models in Animal Breeding. University of Guelph.
- Kearsey, M. J. and H. S. Pooni. 1996. The Genetical Analysis of Quantitative Traits. Chapman & Hall, New York.

- Littell, R. C.; Milliken, G.A.; Strop, W.W.; Wolfinger, R.D. and O. Schabenberger. 2006. SAS for Mixed Models. Second Edition. Cary, NC: SAS Institute Inc.
- Mather, K. and J. L. Jinks. 1977. Introduction to Biometrical Genetics. Cornell University Press, Ithaca, New York.

### **Attendance and Make-Up Work**

“Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: <https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/>

### **Online Course Evaluation Process**

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### **Software Use**

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.

### **Academic Honesty**

As a student at the University of Florida, you have committed yourself to uphold the Honor Code, which includes the following pledge: “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity.” You are expected to exhibit behavior consistent with this commitment to the UF academic community, and on all work submitted for credit at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.”

It is assumed that you will complete all work independently in each course unless the instructor provides explicit permission for you to collaborate on course tasks (e.g. assignments, papers, quizzes, exams). Furthermore, as part of your obligation to uphold the Honor Code, you should report any condition that facilitates academic misconduct to appropriate personnel. It is your individual responsibility to know and comply with all university policies and procedures regarding academic integrity and the Student Honor Code. Violations of the Honor Code at the University of Florida will not be tolerated. Violations will be reported to the Dean of Students Office for consideration of disciplinary action. For more information regarding the Student Honor Code, please see: <http://www.dso.ufl.edu/sccr/process/student-conduct-honor-code>. If you have any questions or concerns, please consult with the instructor or TAs in this class.

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### **Services for Students with Disabilities**

“Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565; <https://disability.ufl.edu/get-started/>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.”

### **Campus Resources**

Students experiencing crises or personal problems that interfere with their general well-being are encouraged to utilize the university's counseling resources. The Counseling & Wellness Center provides confidential counseling services at no cost for currently enrolled students. Resources are available on campus for students having personal problems or lacking clear career or academic goals, which interfere with their academic performance.

*University Counseling & Wellness Center, 3190 Radio Road, 352-392-1575, [www.counseling.ufl.edu/cwc/](http://www.counseling.ufl.edu/cwc/)*  
Counseling Services  
Groups and Workshops  
Outreach and Consultation  
Self-Help Library  
Wellness Coaching

*U Matter, We Care:* If you or someone you know is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu), 352-392-1575, or visit [U Matter, We Care website](#) to refer or report a concern and a team member will reach out to the student in distress.

*Counseling and Wellness Center:* [Visit the Counseling and Wellness Center website](#) or call 352-392-1575 for information on crisis services as well as non-crisis services.

*Student Health Care Center:* Call 352-392-1161 for 24/7 information to help you find the care you need, or [visit the Student Health Care Center website](#).

*University Police Department:* [Visit UF Police Department website](#) or call 352-392-1111 (or 9-1-1 for emergencies).

*UF Health Shands Emergency Room / Trauma Center:* For immediate medical care call 352-733-0111 or go to the emergency room at 1515 SW Archer Road, Gainesville, FL 32608; [Visit the UF Health Emergency Room and Trauma Center website](#).

*GatorWell Health Promotion Services:* For prevention services focused on optimal wellbeing, including Wellness Coaching for Academic Success, visit the [GatorWell website](#) or call 352-273-4450.

## **Academic Resources**

*E-learning technical support:* Contact the [UF Computing Help Desk](#) at 352-392-4357 or via e-mail at [helpdesk@ufl.edu](mailto:helpdesk@ufl.edu)

*Career Connections Center:* Reitz Union Suite 1300, 352-392-1601. Career assistance and counseling services.

*Library Support:* Various ways to receive assistance with respect to using the libraries or finding resources.

*Teaching Center:* Broward Hall, 352-392-2010 or to make an appointment 352-392-6420. General study skills and tutoring.

*Writing Studio:* 2215 Turlington Hall, 352-846-1138. Help brainstorming, formatting, and writing papers.

*Student Complaints On-Campus:* [Visit the Student Honor Code and Student Conduct Code webpage for more information](#).

*On-Line Students Complaints:* [View the Distance Learning Student Complaint Process](#).

## **In-Class Recording**

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in



connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

#### **Privacy statement**

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

#### **Services for Students with Disabilities**

The Disability Resource Center coordinates the needed accommodations of students with disabilities. This includes registering disabilities, recommending academic accommodations within the classroom, accessing special adaptive computer equipment, providing interpretation services and mediating faculty-student disability related issues. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation

0001 Reid Hall, 352-392-8565, [www.dso.ufl.edu/drc/](http://www.dso.ufl.edu/drc/)

**The instructors reserves the right to make changes in the assignments and syllabus as needed. Notification will be via E-Learning, e-mail or class announcements.**