Universitat de Lleida

DEGREE CURRICULUM

PRINCIPLES OF ECOPHYSIOLOGY AND CROP BREEDING

Coordination: SAVIN PARISIER, ROXANA

Academic year 2023-24

PRINCIPLES OF ECOPHYSIOLOGY AND CROP BREEDING 2023-24

Subject's general information

<table>
<tr><td>Subject name</td><td>PRINCIPLES OF ECOPHYSIOLOGY AND CROP BREEDING</td></tr>
<tr><td>Code</td><td>101630</td></tr>
<tr><td>Semester</td><td>2nd Q(SEMESTER) CONTINUED EVALUATION</td></tr>
<tr><td>Typology</td><td>
<table>
<tr><th>Degree</th><th>Course</th><th>Character</th><th>Modality</th></tr>
<tr><td>Bachelor's Degree in Biotechnology</td><td>4</td><td>OPTIONAL</td><td>Attendance-based</td></tr>
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<tr><td>Course number of credits (ECTS)</td><td>6</td></tr>
<tr><td>Type of activity, credits, and groups</td><td>
<table>
<tr><th>Activity type</th><th>PRACAMP</th><th>PRALAB</th><th>PRAULA</th><th>TEORIA</th></tr>
<tr><td>Number of credits</td><td>0.4</td><td>0.6</td><td>1.4</td><td>3.6</td></tr>
<tr><td>Number of groups</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
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<tr><td>Coordination</td><td>SAVIN PARISIER, ROXANA</td></tr>
<tr><td>Department</td><td>AGRICULTURAL AND FOREST SCIENCES AND ENGINEERING</td></tr>
<tr><td>Teaching load distribution between lectures and independent student work</td><td>60 h presenciales
90 h no presenciales</td></tr>
<tr><td>Important information on data processing</td><td>Consult this link for more information.</td></tr>
<tr><td>Language</td><td>Spanish (all professors are capable of teaching in English if necessary)
Some lectures are in English</td></tr>
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PRINCIPLES OF ECOPHYSIOLOGY AND CROP BREEDING 2023-24

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
SAVIN PARISIER, ROXANA	roxana.savin@udl.cat	3,75	
SLAFER , GUSTAVO ARIEL	gustavo.slafer@udl.cat	,5	
SORIANO SORIANO, JOSÉ MIGUEL	josemiguel.soriano@udl.cat	1,75	

Subject's extra information

It is an optional subject offered in the fourth year for the specialty of Degree in Biotechnology. The teaching load is 6 ECTS credits, of which they correspond to 60 classroom hours, divided into theoretical classes (36 hours) and practical classes (24 hours).

Learning objectives

-Understand what are the main determinants of crops yield and quality in order to identify genetic bases for the improvement of these attributes.

-To quantitatively analyze the relationship between environmental factors and the development and growth of crops, focusing attention on the determinants of yield and identifying the critical stages of their formation in order to improve them.

-Identify more or less simple attributes (that could be reliably governed by few genes / QTLs) that allow us to biotechnologically manipulate crop productivity / quality

-Understand the principles of modern plant genetic improvement, including new quantitative and molecular tools such as genomics

-Identify and assess phenotypic and genetic variability and determine which are the components of the variation.

-Understand and use quantitative tools for solving biological, mathematical and statistical problems

-Understand the gene-character association through the determination of genetic maps and QTL detection responsible for characters of economic interest.

-Apply their knowledge to their work in a professional way and have the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

-Be able to transmit information, ideas, problems and solutions to both a specialized and non-specialized audience.

-Acquire learning skills necessary to undertake further studies with a high degree of autonomy.

Competences

General competencies

The graduate in Biotechnology must:

•CG1 Be able to selectively search for and use sources of information necessary to achieve the training objectives.

•CG2 Interpret scientific-technical information with a critical sense, and be able to make presentations based on this information.

•CG3 Work as a team, with a multidisciplinary vision and with the ability to make a rational and effective distribution of tasks among team members.

•CG4 Know and properly use the scientific and technical vocabulary of the different areas of Biotechnology.

• CG5 Work in the laboratory applying quality criteria and good practice.

• CG7 Use the scientific method to analyze data and design experimental strategies with biotechnological applications.

• CG8 Be able to form a critical judgment on the implications of biotechnology at an ethical, legal and environmental level.

• CG9 Be able to carry out a professional activity in accordance with safety and environmental regulations and with ethical criteria.

• CG11 Acquire criteria for choosing the most appropriate analytical techniques for each specific practical case.

Transversals competencies

• CT1 Be able to make comprehensible written and oral reports on the work done, with a justification based on the theoretical and practical knowledge obtained. (Strategic competence of the UdL).

• CT2 Be able to communicate and communicate internationally in their professional development. (Strategic competence of the UdL)

• CT3 Use information and communication tools and techniques for data analysis and the preparation of oral and written reports and other training and professional activities. (Strategic competence of the UdL)

• CT4 Respect the fundamental rights of equality between men and women, the promotion of Human Rights and the values proper to a culture of peace and democratic values. (Strategic competence of the UdL)

Specific competencies (according to study plan document)

• CE14 Know the biology of living beings at their molecular, cellular, organic and population levels, with an emphasis on organisms with biotechnological interest.

• CE19 Know the singularities of genetic analysis and its biotechnological functions.

• CE20 Understand the function of genes and their regulation in response to external changes in the cell.

• CE22 Acquire a precise knowledge of the basic principles and physiological mechanisms of plant organisms.

Subject contents

The subject will be integrated into two central modules, the first on crop ecophysiology in which a conceptual framework of crops develpment and growth will be established as the basis for improving their productivity and

quality, and the second module is on identification and manipulation of the genetic bases of characters of economic interest.

Part I. Ecophysiology of crop yields

1. Introduction Definition and characteristics of cultivated systems and crop ecophysiology.

2. Development Growing season and growing season. Phase and morphological development. Stages of development. Relationship between stages of development and generation of performance components. Factors that affect the duration of the stages of development: direct response to temperature, response to photoperiod, vernalization. Direct response models to temperature, photoperiod and vernalization. Examples of herbaceous cultivated species.

3. Carbon economy Carbon balance. Accumulation of dry matter. Crop growth rate. Incident radiation. Photosynthetically active radiation. Seasonal variation of incident radiation. Radiation interception. Generation of the leaf area. Foliar area index. Critical and optimal leaf area index. Intercept efficiency. Radiation attenuation through canopy. Changes in the interception efficiency before changes in the density and spatial arrangement of plants. Use of radiation. Radiation use efficiency. Variation due to the type of photosynthetic metabolism, ontogeny and the cost of synthesis of the photoassimilates. Factors that reduce the efficiency of radiation use. Photoassimilated partition. Changes in partitioning during crop ontogeny. Source and destination bodies of photoassimilates. Source-destination relationships. Factors that determine the hierarchy of destinations. Performance. Biological yield and economic yield. Importance of the production objective. Numerical and physiological components of performance. Harvest index. Harvest index modifications through improvement. Critical performance definition periods. Potential performance. Estimation of the potential yield of a crop in an environment.

4. Economy of water in crops Crop water balance. Contributions and losses of water in the cultivated system. Energy balance related to water balance. Evapotranspiration: biotic and abiotic factors that control soil evaporation and crop transpiration. Water use efficiency. Observation scales of water use efficiency. Crop management for efficient use of water. Crop response to water stress: mechanisms involved. Characteristics of genotypes and management practices that allow improving yields under drought conditions. 5. Mineral Nutrition Nutrient availability depending on environmental and edaphic factors. Use by cultivation. Effect of nutrient supply on growth and crop yield. Importance of the moment of application of the fertilizer: relation with the components of the yield and the quality of the production objective. Nutrient use efficiencies: agronomic efficiency, physiological efficiency, and recovery fraction. Crop management and production system to optimize the use of nutrients. Nutrient partition. Interactions between the availability of water and nutrients on growth and crop yield.

Part II Identification and manipulation of the genetic bases of characters of economic interest

6. Foundations of Plant Genetic Improvement Population's genetics. Components of variation. Response to selection. Manipulation of the reproductive systems. Applicable strategies and selection of improvement methods. Improvement of pure lines / Improvement of populations / Improvement of hybrids / Improvement of clones

7. Identification of the genetic basis of performance and its physiological determinants. QTls, candidate genes Molecular markers. Ligation and recombination. Gene mapping and QTL. For this, linkage maps will be developed in segregating genetic populations, especially double haploids, using specific commercial software. From these maps, markers associated with the control of qualitative and, particularly, qualitative inheritance characters will be identified.

8. Biotechnology opportunities. Biotechnological tools to improve crop productivity and quality. Selection assisted by molecular markers. Plant genomes. Gene discovery. Diversity of DNA sequences. Genomic and bioinformatic databases. Dissection of complex characters. Candidate genes. Selection assisted by molecular markers.

Practical activities

Practice 1. States of development, determination and meaning. Dissections and determinations of the generation of vegetative and reproductive structures

Practice 2. Determination of the capacity of the resource capture culture, IAF, radiation interception

Practice 3. Performance and performance components. Utility and drawbacks

Practice 4. Attributes of the radical system and capture of edaphic resources

Practice 5. Absorption and use of nitrogen. Determination of accumulated N and of the efficiency in the use of nitrogen

Practice 6. Visit to a flour wheat improvement program

Practice 7. Determination of genetic maps using JoinMap

Practice 8. Detection of QTL using MapQTL

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Methodology

Tipo de actividad	Descripción	Actividad presencial alumno		Actividad no presencial alumno		Evaluación	Tiempo total
		Objectivos	**Horas**	**Trabajo alumno**	**Horas**	**Horas**	**Horas**
Lliçó magistral	Classe magistral (Aula. Grup gran)	Explicació dels principals conceptes	**36**	Estudi: Conèixer, comprendre i sintetitzar coneixements	**60**	4	**100h/4 ECTS**
Problemas y casos	Classe participativa (Aula. Grup gran)	Resolució de problemes i casos	**10**	Aprendre a resoldre problemes i casos	**10**		**20 h/0.80 ECTS**
Seminarios	Classe participativa (Grup mitjà)	Realització d'activitats de discussió o aplicació	**2**	Resoldre problemes i casos. Discutir	**6**	0	**8 h/ 0.32 ECTS**
Laboratorio	Pràctica de Laboratori (Grup mitjà)	Execució de la pràctica: comprendre fenòmens, mesurar...	**4**	Estudiar i realitzar Examen			**4 h/ 0.16 ECTS**
Aula de nformatica	Pràctica d'aula d'informàtica (Grup mitjà)	Execució de la pràctica: comprendre fenòmens, mesurar...	**4**	Estudiar i Realitzar memòria	**5**	0	**9 h/ 0.36 ECTS**

Practicas de campo	Practica de camp (Grup mitjà)	Execució de la pràctica: comprendre fenòmens, mesurar...	**4**	Estudiar i Realitzar memòria	**5**		**9 h/0.36 ECTS**
Visitas	Visita a explotacions o industries	Realització de la visita		Estudiar i Realitzar memòria			
Actividades dirigidas	Treball de l'alumne (individual o grup)	Orientar a l'alumne en el treball (en horari de tutories)		Realitzar un treball bibliogràfic, pràctic, etc.			
Otros							
Totales			**60**		**86**	4	**150h / 6 ECTS**

Evaluation

Activity	Evaluation		Porcentage
	Procedimiento	**Number**	
Master class	Examens	2	**60**
Laboratory and field practices	Exercises	6	**25**
Seminars	Oral presentation	1	**10**
Laboratory informatic	Delivery of reports	1	**5**
Total			**100**

Observations

Attendance at all practical laboratory and field sessions is compulsory. To pass the course it will be necessary to obtain a grade equal to or greater than 5 points in the different activities. In theory, it will be necessary to obtain a 5 in all the written tests to pass it. If not, it will be necessary to make up the exams with a grade lower than 5.

Bibliography

Basic References

Crop Physiology

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-Loomis, R., Connor, D. 1992. Crop Ecology. Productivity and Management in Agricultural Systems. Cambridge University Press. Cambridge. Reino Unido. Traducido al castellano: Ecología de

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-Sadras, V.O, Calderini, D.F., 2009. Crop Physiology: Applications for Genetic Improvement and Agronomy Elsevier, USA

-Villalobos, F.J.; Mateo, L.; Orgaz, F.; Fereres, E. 2002. Fitotecnia: Bases y tecnologías de la producción agrícola. Mundi-Prensa. Madrid.

Identification of genetic bases

-Kersey M.J. HS Pooni. 2006. The Genetical Analysis of Quantitative Traits. Chapman and May. London. 381 pp.

-Lynch M, Walsh B. 1997. Genetics and Analysis of Quantitative Traits. Sinauer. Sunderland. Paterson, A. 1998. Molecular Dissection of Complex traits. CRC.

-Cubero JI. 2003 Introduccion a la Mejora Genetica Vegetal Mundiprensa. Madrid

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-Andrade, F.H., Sadras, V.O., 2000. Bases para el manejo del maíz, el girasol y la soja. INTA- Universidad de Mar del Plata, Argentina, 443 p

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-Satorre, E.H., Benech Arnold, R.L., Slafer, G.A., De la Fuente, E., Miralles, D.J., Otegui, M.E., Savin, R., 2003. Producción de Cultivos de Granos. Bases funcionales para su manejo. Editorial Facultad de Agronomía, Buenos Aires, Argentina, 783 p.

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-Slafer, G.A., 1994. Genetic Improvement of Field Crops. Marcel Dekker, Inc., New York, 1994. 470 pp.

-Slafer, G.A., Molina-Cano, J.L., Savin, R., Araus, J.L., Romagosa, I., 2002. Barley Science. Recent advances from molecular biology to agronomy of yield and quality, Food Product Press, New York, USA, 565 p

-Evans, L.T. 1993. Crop Evolution, Adaptation and Yield. Cambridge University Press. Cambridge. Reino Unido.