Subject identification

Subject	10003 - Plant Reactions under Hydric Stress
Credits	1.2 attended (30 Hours) 3.8 non-attended (95 Hours) 5 total (125 Hours).
Group	Group 1, 2S
Semester	
Teaching language	

Lecturers

Lecturers	Office hours for students					
	Start time	End time	Dia	Start date	End date	Despatx
Miquel Ribas Carbó mribas@uib.cat	There are no sessions set					
Jaume Flexas Sans jaume.flexas@uib.es	There are no sessions set					

Degrees where the subject is taught

Degree	Character	Course	Studies
Master in Biology of Plants in Mediterranean Conditions	Optional		Postgraduate degree

Contextualisation

Water stress is the most limiting factor for crop and forest productivity worldwide. The effects of water stress on productivity are mediated by plant molecular, physiological and morphologic responses to water stress. The understanding of these responses is crucial to improve plant pridyctivity and water use efficiency in water-scarce environments.

Requirements

Recommended

For a proper understanding of the contents of this course, it is highly recommendable to have previously followed the course on 'Ecophysiological techniques'.

It may be also useful to have followed the courses on 'Plant water use' and on 'Water use efficiency'

Skills

Specific

1. Knowing the concepts of water stress, water deficit and drought, their relationships and differences, and how do they opperate in different environments, soil types, etc. Understanding and modelling water stress-induced reductions of plant growth.
2. Acquiring a complete view on the different proposed mechanisms and factors leading to stomatal closure under water stress.
3. Detailed understanding of photosynthesis and respiration to water stress and rewatering. Understanding photoprotection and photoinhibition uder water stress..
4. Linking physiological responses to water stress to plant productivty, yield and fruit characteristics. Assessing the usefulness of physiological tools and perspectives for irrigation scheduling and defining potential targets for biotechnological improvement of plant productivity and water use efficiency in drought prone environments.

General

1. Acquiring an actualised view of the elements determining plant responses to water stress.
2. Understanding plant responses to water stress at different levels: adaptation, acclimation and immediate responses.

Content

Thematic content

Introduction. Introduction

Introcution to concepts related to water stress and plant responses. Drought, water stress and water deficit. Plant responses, acclimation and adaptation.

Stomatal regulation. Stomatal regulation

Stomatal regulation under water stress. Hormonal signals. Hydraulic signals. Other signals: electrical signals?

Growth and thermal responses. Growth and thermal responses

Models of growth responses to water stress. Water stress effects on plant energy and thermal balance.

Photosynthesis responses to water stress. Photosynthesis responses to water stress

Photosynthesis responses to water stress. Stomatal versus non-stomatal limitations. The importance of mesophyll conductance to CO2. Inhibition of photosynthetic metabolism. Interactions with high light stress.

Respiration responses to water stress. Respiration responses to water stress

Respiration responses to water stress. Photorespiration versus mitochondrial respiration. Cytochrome versus alternative pathways.

Photoprotection responses to water stress. Photoprotection responses to water stress

Photoprotection and photoinhibition under water stress. Light-avoiding mechanisms. Energy dissipation: the xanthophyll cycle. Antioxidant mechanisms. D1 protein degradation and repair.

From plant responses to yield and fruit characteristics. From plant responses to yield and fruit characteristics

Linking growth, photosynthesia and respiration with whole plant arbon gain, productivity, fruit yield and quality. A case study with grapevines.

Improving water use efficiency. Improving water use efficiency

Physiologically-based tools for monitoring plant water status and irrigation scheduling. Field devices and remote sensing indices. Designing plant traits for biotechnology improvements of plant water use efficiency,

Teaching methodology

Attended activities

Type	Name	G. type	Description
Theory classes	Lectures	Large group (G)	Aim: presenting and actualized knowledge on the subjects of the course Methodology: lectures
Seminars and workshops	Paper seminars	Medium group (M)	Aim: discussing novel aspects / advances on the different subjects of the course Methodology: discussion of previously read articles (selected by each student over those published in the last 5 years)
Assessment	Evaluation	Large group (G)	Aim: evaluating acquired knowledge Methodology: written exam (open questions)

Non-attended activities

Type	Name	Description
Individual self-study	Study	Aim: studying the contents of lectures Methodology: study
Individual self-study	Paper term	Aim: to deepen in the knowledge of particularly selected aspects Methodology: reading, understanding, summarizing and orally presenting the main aspects of a paper read on a particular subject related to the course

Type	Name	Description
Group self-study	Debate	Aim: to deepen in the knowledge of particularly selected aspects Methodology: open debate on the exposed summaries of selected papers

Workload estimate

Type	Name	Hours	ECTS	%
Attended activities		**30**	**1.2**	**24**
Theory classes	Lectures	24	0.96	19.2
Seminars and workshops	Paper seminars	4	0.16	3.2
Assessment	Evaluation	2	0.08	1.6
Non-attended activities		**95**	**3.8**	**76**
Individual self-study	Study	87	3.48	69.6
Individual self-study	Paper term	6	0.24	4.8
Group self-study	Debate	2	0.08	1.6
	Total	**125**	**5**	**100**

At the beginning of the semester the subject schedule will be available to students through the UIBdigital platform. This schedule will at least include the dates for the continuous assessment exams and assignment deadlines. Furthermore, the lecturer will inform students as to whether the subject syllabus will be carried out according to the schedule or otherwise, including Campus Extens.

Student learning assessment

Paper seminars

Type	Seminars and workshops
Technique	Oral tests **(Non-recoverable)**
Description	Aim: discussing novel aspects / advances on the different subjects of the course Methodology: discussion of previously read articles (selected by each student over those published in the last 5 years)
Assessment criteria	Quality and clarity of presentation

Final mark percentage: 20% for pathway A

Evaluation

Type	Assessment
Technique	Short-answer tests **(Non-recoverable)**
Description	Aim: evaluating acquired knowledge Methodology: written exam (open questions)
Assessment criteria	Achievement of precise knowledge on the different aspects of the course

Final mark percentage: 40% for pathway A

Study

Type	Individual self-study
Technique	Short-answer tests **(Non-recoverable)**
Description	Aim: studying the contents of lectures Methodology: study
Assessment criteria	Achievement of precise knowledge on the different aspects of the course

Final mark percentage: 10% for pathway A

Paper term

Type	Individual self-study
Technique	Oral tests **(Non-recoverable)**
Description	Aim: to deepen in the knowledge of particularly selected aspects Methodology: reading, understanding, summarizing and orally presenting the main aspects of a paper read on a particular subject related to the course
Assessment criteria	Quality and clarity of understanding and summarizing

Final mark percentage: 20% for pathway A

Debate

Type	Group self-study
Technique	Oral tests **(Non-recoverable)**
Description	Aim: to deepen in the knowledge of particularly selected aspects Methodology: open debate on the exposed summaries of selected papers
Assessment criteria	Interest and demonstration of advanced knowledge

Final mark percentage: 10% for pathway A

Resources, bibliography and additional documentation

Basic bibliography

Araus JL, Slafer GA, Reynolds MP, Royo C (2002) Plant breeding and drought in C3 cereals: What should we breed for' Ann Bot 89: 925-940
Bacon MA (2004) Water Use Efficiency in plant biology. In: Bacon MA (eds) Water Use Efficiency in Plant Biology, Blackwell Publishing Ltd., Oxford, pp 1-22
Boyer JS (1982) Plant productivity and environment. Science 218, 443-448
Boyer JS (1996) Advances in drought tolerance in plants. Adv Agron 56: 187-218

Chaves M.M., Pereira, J Maroco, Ml Rodrigues, Cpp Ricardo, Ml Osório, I Carvalho, T Faria & C Pinheiro (2002) How plants cope with water stress in the field. Photosynthesis and growth. Annals of Botany 89: 907-916.
Chaves, M. M., Maroco, J. P., and Pereira, J. S. (2003) Understanding plant responses to drought - from genes to the whole plant. Functional Plant Biology 30, 239-264.
Chaves MM, Oliveira MM (2004) Mechanisms underlying plant resilience to water deficits: prospects for water-saving agriculture. Journal of Experimental Botany 55, 2365-2384.
Caldwell MM, Dawson TE, Richards JH (1998) Hydraulic lift: consequences of water efflux from the roots of plants. Oecologia 113, 151-161.
Canadell J, Jackson RB, Ehleringer JR, Mooney HA, Sala OE, Schulze E-D (1996) Maximum rooting depth of vegetation types at a global scale. Oecologia 108, 583-595.
Condon AG, Richards RA, Rebetzke GJ, Farquhar GD (2004) Breeding for high water-use efficiency. J Exp Bot 55: 2447-2460
Morison, J.I.L., Baker, N.R., Mullineaux, P.M., and Davies, W.J. (2008) Improving water use in crop production. Philosophical Transactions of the Royal Society of London series B 363, 639-658.
Murchie, E.H., Pinto, M. and Horton, P. (2009) Agriculture and the new challenges for photosynthesis research. New Phytologist 181, 532-552.
Parry MAJ, Flexas J, Medrano H (2005) Prospects for crop production under drought: research priorities and futures directions. Ann App Biology 147: 211-226

Additional bibliography

A detailed list of papers on each subject of the course will be provided immedately before the starting of the course