



Univerza v Mariboru

Fakulteta za naravoslovje
in matematiko

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Izbor iz fiziološke ekologije rastlin
Course title:	Selection in Physiological Plant Ecology

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Doktorski študij Ekološke znanosti, 3. stopnja		1. ali 2.;	1., 2. ali 3.;
Doctoral Study Ecological Sciences, 3rd degree		1st or 2nd	1st or 2nd or 3rd

Vrsta predmeta / Course type

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Lab. vaje Laboratory work	Terenske vaje Field work	Samost. delo Individ. work	ECTS
5			5		140	5

Nosilec predmeta / Lecturer:

Jeziki / Predavanja / Lectures:
Languages: Vaje / Tutorial:

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Poznavanje fiziologije rastlin na ravni dodiplomskega študija

Prerequisites:

Knowledge of physiological plant ecology at graduate level

Vsebina:

V predmetu so podrobno obravnavana izbrana poglavja iz vpliva naravnih in antropogenih stresnih dejavnikov na fiziološke procese v rastlini s poudarkom na funkcijskih motnjah celičnega metabolizma in odzivom rastlin na stresne dejavnike na nivoju celic in cele rastline

A) Funkcijske motnje celičnega metabolizma

- Toksični efekti kisika na rastline

Tvorba prostih kisikovih radikalov, reakcije v celici;

- Motnje v metabolizmu ogljika

Vplivi okoljskih dejavnikov na fotosintezo, fotorespiracijo, dihanje ter pretok in porabo ogljikovih hidratov v rastlini

Content (Syllabus outline):

The lecture focuses on selected chapters on the impact of natural and anthropogenic stress factors on physiological processes in plants with the special emphasis on functional disturbances of cell metabolism and the response of plants to stress factors on the cellular and the whole plant level.

A) Functional disturbances of cell metabolism

- Toxic effects of oxygen on plants

Formation of reactive oxygen species and reactions in the cell

- Disturbances in carbon metabolism

The influence of external factors on photosynthesis, photorespiration, respiration, the translocation and

- Motnje v mineralni prehrani

Vpliv okolja na presnovo mineralov; motnje v preskrbi; vpliv na simbiozo z rizosfernimi mikroorganizmi; podrobneje so izpostavljene motnje v privzemu, asimilaciji ter transportu žvepla, amonija in nitrata ter vgradnja v ogljikove spojine

B) Odzivi rastlin na stresne dejavnike

Obrambni in reparaturni mehanizmi, detoksifikacija prostih kisikovih radikalov z antioksidanti in encimi; sinteza, kompartmentacija in vloga antioksidantov; aktualna dognanja o vlogi glutaciona, askorbinske kisline, tokoferola in karotinooidov v obrambi pred oksidativnim stresom

Posebni poudarek je na predstavitvi lastnih raziskav v okviru naslednjih učnih sklopov:

1. Daljinski transport vode v drevesu (Fiziološko ozadje ksilemskega toka, povezava med ksilemskim tokom, evapotranspiracijo in fotosintezo, principi meritev vodnega statusa rastlin, meritve ksilemskega toka s TDP (thermal dissipation probe, tipalo termičnega odvoda) in HPV (Heat pulse velocity) senzorji, predstavitev rezultatov merjenja ksilemskega toka v smreki po napadu podlubnikov in okužbi z glivo *Ceratocystis polonica*).

2. Vloga metabolizma žvepla v rastlinah in prilagoditvi na abiotični/biotični stres v kmetijskih ekosistemih

3. Biokemične in strukturne spremembe rastlinskih tkiv kot posledica fizioloških motenj na hortikulturnih rastlinah

Vloga antocianskih vakuolarnih vključkov (AVI, anthocyanic vacuolar inclusions) na barvo cvetov in plodov v povezavi s pomanjkanjem kalcija

Programirana celična smrt v povezavi s fiziološkimi motnami

4. Bioindikacija onesnaževanja okolja

Reakcijski in akumulacijski indikatorji, kazalci in testni organizmi, metode biomonitoringa, vloga glutaciona v detoksifikaciji težkih kovin.

5. Termogeneza aroidnih vrst: fiziološko ozadje termogeneze (regulacija, vloga alternativne oksidaze, vloga salicilne kisline in etilena, hlapni sekundarni metaboliti) ultrastrukturne posebnosti tkiv spadiksa in površine spate, ekološki aspekt termogeneze, 4 tipi termogeneze (morfološke in fiziološke posebnosti, časovni potek gretja posameznih tipov termogeneze), predstavitev

utilization of photosynthates in plants

- Disturbances in mineral nutrition

Habitat-related aspects of mineral metabolism; the disturbances in supply; the impact on symbiosis with the microorganisms in rhizosphere; the chapter focuses on the disturbances in the uptake, assimilation and transport of sulphur, ammonium ions and nitrate and their incorporation into carbon compounds

B) The response of plants to stress factors

Defense and reparatory mechanisms, detoxification of reactive oxygen species with antioxidants and enzymes; synthesis, compartmentation and function of antioxidants; recent advances in the role of glutathione, ascorbate, tocoferol and carotinoide in defense against oxidative stress

Special emphasis is placed on presenting our own research within the following learning packages:

1. Long distance transport of water in trees (Physiological background of xylem flow, link between xylem flow, evapotranspiration and photosynthesis, principles of sap flow measurement techniques with TDP (thermal dissipation probe) and HPV (Heat pulse velocity) sensors. Presentation of our own results of sap flow measurements in spruce affected by bark beetles and *Ceratocystis polonica* infection).

2. The impact of sulfur metabolism in plants and adaptation to abiotic/biotic stress in agricultural ecosystems

3. Biochemical and structural changes in plant tissues as a result of physiological disorders in horticultural crops

The impact of anthocyanic vacuolar inclusions (AVIs) on the color of flowers and fruits and alterations caused by calcium deficiency
Programmed cell death in relation to the physiological disorders

4. Bioindication of pollution impacts

Response and accumulation indicators, indicators and test organisms, biomonitoring methods, the role of glutathione in the detoxification of heavy metals.

5. Termogenesis of aroid species: physiological background of termogenesis (regulation, the role of alternative oxidase, the role of salicylic acid and ethylene, volatile secondary metabolites); ultrastructural characteristics of spadix and the

znanstvenih objav in raziskovalnega dela na rodovih *Alocasia*, *Colocasia* in *Arum*, predstavitev rezultatov raziskav v okviru mednarodnega projekta INEA (International Network for Edible Aroids).

surface of the spathe, ecological aspect of thermogenesis, 4 types of thermogenesis (morphological and physiological characteristics, the time course of heating process in different thermogenesis types), presentation of scientific publications and research on the genera *Alocasia*, *Colocasia* and *Arum*, presentation of research results within the international project INEA (international Network for Edible Aroids).

Temeljni literatura in viri / Readings:

- Grill, D., M. Tausz, L. J. De Kok, 2001: Significance of glutathione to plant adaptation to the environment. Kluwer academic publishers, Dordrecht.
- Inzé, D., M. Van Montagu, 2002: Oxidative stress in plants. Taylor & Francis, Inc., New York.
- Larcher, W., 1991: Physiological Plant Ecology. Springer, Heidelberg.
- Taiz, L., E. Zeiger, 2012: Plant Physiology. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts.
- Varma, A., R. P. Beckett, I. Kranner, 2002: Protocols in Lichenology: Culturing, Biochemistry, Ecophysiology, and Use in Biomonitoring. Springer, Heidelberg.

Znanstvene revije:

The Plant Cell

Plant Cell and Environment

Plant and Cell Physiology

Journal of Plant Biotechnology

Trends in Plant Science

Trees-Structure and Function

Botany

Forest Ecology and Management

Cilji in kompetence:

- Posebna pozornost je posvečena izbranim odzivom rastlin na izbrane okoljske dejavnike
- Obravnava izbranih toksičnih učinkov kisika
- Obravnava funkcijskih motenj celičnega metabolizma
- Obravnava izbranih simptomov poškodb na nivoju celic in celega organizma
- Obravnava v izbrane obrambne in reparativne mehanizme
- Obravnava izbranih analitičnih metod v ekofiziologiji in stresni fiziologiji rastlin

Objectives and competences:

- Special attention is paid to the selected responses of plants to stress factors
- Illustration of selected toxic effects of oxygen
- selected functional disturbances in cell metabolism
- Illustration of selected injury patterns and symptoms on cell and whole plant level
- selected defense and reparatory mechanisms
- selected analytical measurements in ecophysiology and stress physiology of plants

Predvideni študijski rezultati:

Intended learning outcomes:

Znanje in razumevanje:

- Znanje in razumevanje odziva rastlin na izbrane okoljske dejavnike
- Razumevanje toksičnih učinkov kisika
- Poznavanje stresnih faktorjev, prepoznavanje simptomov poškodb in osnovnih obrambnih in reparativnih mehanizmov
- Usvojitev izbranih metod v ekofiziologiji

Prenesljive/ključne spretnosti in drugi atributi:

- Pridobitev vrhunskega znanja o principih in metodah v ekofiziologiji in stresni fiziologiji rastlin ter uporaba le tega v praksi

Knowledge and Understanding:

- Top-level knowledge and understanding of the response of plants to stress factors
 - Top-level understanding of toxic effects of oxygen
 - Top-level knowledge of stress factors, identification of injury patterns and symptoms, understanding the basic defense and reparatory mechanisms
 - Methods and ecophysiological equipment
- Transferable/Key Skills and other attributes:**
- Achieving top-level knowledge about the principles and methods in ecophysiology and stress physiology for good practice

Metode poučevanja in učenja:

- Predavanja
- Izbrane fitofiziološke raziskave z uporabo biokemičnih in fizioloških metod v laboratoriju in na terenu s poudarkom na morfologiji in funkciji rastlin pod vplivom okolja
- Samostojno delo

Learning and teaching methods:

- Lectures
- Selected phytophysiological research using biochemical and physiological methods in laboratory and in field with special attention to environmental impacts to plant morphology and functions
- Independent work

Delež (v %) /
Weight (in %)

Načini ocenjevanja:

- Seminarjska naloga in njena predstavitev
- Laboratorijski dnevnik
- Pisni izpit

30%
20%
50%

Assessment:

- Seminar essay and its defense
- Diary of laboratory results
- Written exam

Reference nosilca / Lecturer's references:

NOVAK, Metka, URBANEK KRAJNC, Andreja, LAH, Ljerka, ZUPANEC, Neja, KRAŠEVEC, Nada, KRIŽMAN, Mitja, BOHLMANN, Joerg, KOMEL, Radovan. Low-density *Ceratocystis polonica* inoculation of Norway spruce (*Picea abies*) triggers accumulation of monoterpenes with antifungal properties. *European journal of forest research (Print)*, ISSN 1612-4669, Jul. 2014, vol. 133, no. 4, str. 573-583, ilustr., doi: [10.1007/s10342-013-0772-4](https://doi.org/10.1007/s10342-013-0772-4).

URBANEK KRAJNC, Andreja, NOVAK, Metka, FELICIJAN, Mateja, KRAŠEVEC, Nada, LEŠNIK, Mario, ZUPANEC, Neja, KOMEL, Radovan. Antioxidative response patterns of Norway spruce bark to low-density *Ceratocystis polonica* inoculation. *Trees*, ISSN 0931-1890, 2014, vol. 28, iss. 4, str. 1145-1160, doi: [10.1007/s00468-014-1025-y](https://doi.org/10.1007/s00468-014-1025-y).

URBANEK KRAJNC, Andreja, TURINEK, Maja, IVANČIČ, Anton. Morphological and physiological changes during adventitious root formation as affected by auxin metabolism : stimulatory effect of auxin containing seaweed extract treatment. *Agricultura*, ISSN 1580-8432. [Print ed.], nov. 2013, vol. 10, no. 1/2, str. 17-27,

ilustr. [COBISS.SI-ID [3641132](#)]

URBANEK KRAJNC, Andreja, KRISTL, Janja, IVANČIČ, Anton. Application of salicylic acid induces antioxidant defense responses in the phloem of *Picea abies* and inhibits colonization by *Ips typographus*. *Forest Ecology and Management*, ISSN 0378-1127. [Print ed.], 2011, letn. 261, št. 3, str. 416-426, doi: [10.1016/j.foreco.2010.10.027](https://doi.org/10.1016/j.foreco.2010.10.027). [COBISS.SI-ID [3066156](#)]

URBANEK KRAJNC, Andreja, IVANUŠ, Anja, KRISTL, Janja, ŠUŠEK, Andrej. Seaweed extract elicits the metabolic responses in leaves and enhances growth of pelargonium cuttings. *European journal of horticultural science*, ISSN 1611-4426, 2012, letn. 77, št. 4, str. 170-181. [COBISS.SI-ID [3355436](#)]