



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.-4.
Doctoral Study Ecological Sciences, 3rd degree		1st or 2nd	1st-4th

Vrsta predmeta / Course type

Izbirni/Elective

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Terenske vaje Field excursions tutorial	Laboratorijske vaje Laboratory work	Druge oblike študija	Samost. delo Individ. work	ECTS
18	4	4	4		150	6

Nosilec predmeta / Lecturer:

Andreja URBANEK KRAJNC

Jeziki /

Languages:

Predavanja /

Lectures:

slovenščina / Slovene

Vaje / Tutorial:

slovenščina / Slovene

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

Ni pogojev.

Prerequisites:

No prerequisites.

Vsebina:

V predmetu se podrobno obravnavana izbrana poglavja iz vpliva naravnih (abiotskih in biotskih) 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

Negativen učinek reaktivnih kisikovih vrst (ROS) na subceličnem nivoju, motnje v metabolizmu ogljika, motnje v mineralni prehrani, spremembe v sekundarnem metabolizmu

B) Odzivi rastlin na stresne dejavnike

Obrambni in reparaturni mehanizmi, detoksifikacija ROS z antioksidanti in encimi; sinteza, kompartmentacija in vloga antioksidantov; aktualna dognanja o vlogi glutationa, askorbinske kisline, tokoferola in karotinoidov 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 vodne bilance 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 abiotski/biotski stres v kmetijskih ekosistemih.

3. Vloga parazitskih ogorčic v biotičnem varstvu rastlin pred škodljivimi organizmi. Predstavitev rezultatov raziskav vključujoč strune in polže kot škodljive organizme. Raziskave hlapnih

Content (Syllabus outline):

The lecture focuses on selected chapters on the impact of natural (abiotic and biotic) 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

Negative effects of reactive oxygen species (ROS) on subcellular level, disturbances in carbon metabolism, disturbances in mineral nutrition, alterations in secondary metabolism
Habitat-related aspects of mineral metabolism;

B) The response of plants to stress factors

Defense and reparatory mechanisms, detoxification of ROS with antioxidants and enzymes; synthesis, compartmentation and function of antioxidants; recent advances in the role of glutathione, ascorbate, tocoferol and carotinoides in defense against oxidative stress.

Particular emphasis is placed on the presentation of the lecture's own research in the following learning packages:

1. Long distance transport of water in trees (physiological background of xylem flux, relationship between xylem flux, evapotranspiration and photosynthesis, principles of techniques to measure water flux with TDP (thermal dissipation probe) and HPV (heat pulse velocity) sensors. Presentation of own results of sap flow measurements on spruce affected by the bark beetle and *Ceratocystis polonica* infection).

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

3. The role of parasitic nematodes in the biological control of plants against harmful organisms. Presentation of research results, including wireworms and slugs as harmful organisms. Research on volatile compounds

snovi, ki jih izloča gostitelj, povezanih z biotičnim varstvom rastlin.

4. 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 motnjami.

5. Bioindikacija onesnaževanja okolja

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

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

7. Inventarizacija, morfološke in biokemijske raziskave murv, reintegracija morikulture.

Pomen fitolitov v listih murv v odzivu na stres. Fitoremediacijski učinek murv.

released by the host, related to the biological control of plants.

4. Biochemical and structural changes in plant tissues as a result of physiological disturbances in horticultural crops. The effects of anthocyanic vacuolar inclusions (AVI) on flower and fruit colour in respect to calcium deficiency. Programmed cell death associated with physiological disorders.

5. Bioindication of pollution effects

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

6. Termogenesis of the aroid species:

physiological background of thermogenesis (regulation, the role of alternative oxidase, the role of salicylic acid and ethylene, volatile secondary metabolites); ultrastructural features of the spadix and the surface of the spathe, ecological aspect of thermogenesis, 4 types of thermogenesis (morphological and physiological features, time course of the heating process in the different types of thermogenesis), presentation of scientific publications and research on the genera *Alocasia*, *Colocasia* and *Arum*, presentation of research results in the framework of the international project INEA (International Network for Edible Aroids).

7. Inventory, morphological and biochemical analyses of the mulberry, reintegration of moriculture. The role of phytoliths in mulberry leaves in relation to stress. Phytoremediation effect of mulberries.

Temeljni literatura in viri / Readings:

OBVEZNA LITERATURA:

Taiz, L., Zeiger, E. (2002). *Plant Physiology*. 3th Edition. Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts.

Larcher, W. (2003). *Physiological plant ecology: ecophysiology and stress physiology of functional groups*. Springer Science & Business Media.

DODATNA LITERATURA:

-Učbeniki:

Jones, H. G. (2014). *Plants and microclimate: a quantitative approach to environmental plant physiology*. Cambridge university press.

Willey, N. (2018). *Environmental plant physiology*. Garland Science.

Sadras, V., & Calderini, D. (2009). *Crop physiology: applications for genetic improvement and agronomy*. Academic Press.

URBANEK KRAJNC, Andreja, KOZMOS, Martin. *ARACNE - Guidance model to collect mulberry samples*. [Maribor: University of Maribor, Faculty of agriculture and life sciences], 2023. 1 spletni vir (1 pdf datoteka (68 str.)), ilustr. <https://aracneproject.eu/wp-content/uploads/2023/10/aracne-project-del-1.3.pdf>. [COBISS.SI-ID [149503235](#)]

URBANEK KRAJNC, Andreja, KOZMOS, Martin, RABENSTEINER, Johannes, FILA, Gianni, CAPPELLOZZA, Silvia. *ARACNE "Advocating the role of silk art and cultural heritage at national and European scale". Deliverable 1.3, Specification guide and manual to correctly use the Morus sp. Census application*. [Maribor: University of Maribor, Faculty of agriculture and life sciences], 2023. 1 spletni vir (1 pdf datoteka (54 str.)), ilustr. https://www.fkbv.um.si/wp-content/uploads/2023/06/ARACNE_Morus-APP_Mulberry-specification-guide-and-manual.pdf. [COBISS.SI-ID [204727299](#)]

BATIČ, Franc, BATTELLI, Claudio, CIMERMAN, Aleksa, JOGAN, Jernej, DOLENC KOCE, Jasna, URBANEK KRAJNC, Andreja, KREFT, Ivan, KOŠMRLJ-LEVAČIČ, Borislava, MARTINČIČ, Andrej, SELIŠKAR, Andrej, SURINA, Boštjan, ŠIRCELJ, Helena, TURK, Boris, VODNIK, Dominik, BATIČ, Franc (urednik), KOŠMRLJ-LEVAČIČ, Borislava (urednik), PORENTA, Alenka (urednik). *Botanični terminološki slovar*. 2., dopolnjena in pregledana izd. Ljubljana: Založba ZRC, 2023. 1 spletni vir. Zbirka Terminologiče. ISBN 978-961-05-0734-5. ISSN 2385-9598. <https://isifr.zrc-sazu.si/sl/terminologisce/slovarji/botanicni>, DOI: [10.3986/9789610507345](https://doi.org/10.3986/9789610507345). [COBISS.SI-ID [149684483](#)]

Cilji in kompetence:

- Posebna pozornost je posvečena izbranim odzivom rastlin na izbrane okoljske dejavnike
- Poznavanje daljinskega transporta vode
- Prepoznavanje izbranih toksičnih učinkov kisika

Objectives and competences:

- Special attention is paid to the selected responses of plants to stress factors
- Knowledge of water long distance transport
- Illustration of selected toxic effects of oxygen

- Poznavanje funkcijskih motenj celičnega metabolizma
 - Vpogled v simptome poškodb na nivoju celic in celega organizma
 - Obravnava v izbrane obrambne in reparaturne mehanizme
 - Poznavanje pomena termogeneze v biologiji cvetenja
- Obravnava izbranih analitičnih metod v ekofiziologiji in stresni fiziologiji rastlin

- selected functional disturbances in cell metabolism
- Knowledge of injury patterns and symptoms on cell and whole plant level
- An insight into the defense and reparatory mechanisms
- Knowledge of the role of thermogenesis in floral biology
- selected analytical measurements in ecophysiology and stress physiology of plants

Predvideni študijski rezultati:

- Znanje in razumevanje:
- Študentje bodo pridobili z nanje in razumevanje odziva rastlin na izbrane okoljske dejavnike
 - Povezali bodo razumevanje toksičnih učinkov kisika
 - Pridobili bodo poznavanje stresnih faktorjev, prepoznavanje simptomov poškodb in osnovnih obrambnih in reparaturnih mehanizmov
 - Uporabljali bodo izbran metod v ekofiziologiji
- Prenosljive/ključne spretnosti in drugi atributi:
- Pridobitev vrhunskega znanja o principih in metodah v ekofiziologiji in stresni fiziologiji rastlin ter uporaba le tega v praksi

Intended learning outcomes:

- Knowledge and Understanding:
Students will gain knowledge and understanding of plant response to selected environmental factors
- They will make a connection understanding of the toxic effects of oxygen
 - They will acquire knowledge of stress factors, recognition of symptoms of injury and basic defence and repair mechanisms
 - They will apply selected methods of ecophysiology
- 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
 - Laboratorijske vaje
 - Terenske vaje
- (Izbrane fitofiziološke raziskave z uporabo biokemičnih in fizioloških metod v laboratoriju in na terenu) Samostojno delo

Learning and teaching methods:

- Lectures
 - Laboratory work
 - Field work
- (Selected phytophysiological research using biochemical and physiological methods in laboratory and in field) Individual work

Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

Pisni izpit	50%	Written exam
Laboratorijsko delo	25%	Laboratory work
Seminarska naloga	25%	Seminar paper

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Reference nosilca / Lecturer's references:

1. Senekovič, J., Jelen, Š., & UrbaneK Krajnc, A. (2025). Copper Sulfate Elicitation Effect on Biomass Production, Phenolic Compounds Accumulation, and Antioxidant Activity of *Morus nigra* L. Stem Node Culture. *Plants*, 14(5), 766.
2. Laznik, Ž., Križman, M., Zekič, J., Roškarič, M., Trdan, S., & UrbaneK Krajnc, A. (2024). Navigational Signals for Insect and Slug Parasitic Nematodes: The Role of Ascorbate–Glutathione System and Volatiles Released by Insect-Damaged Sweet Pepper Roots. *Insects*, 15(10), 805.
3. Jelen, Š., & Krajnc, A. U. (2023). Composition of proteins and phenolics in the leaves of different mulberry species (*Morus alba* L., *M. alba* × *rubra*, *M. australis* Poir., *M. nigra* L.). *Agricultura Scientia*, 20(1), 23-33.
4. Ambrožič-Dolinšek, J., Podgrajšek, A., Šabeder, N., Grudnik, Z. M., UrbaneK Krajnc, A., Todorović, B., & Ciringer, T. (2023). The potential of *Berula erecta in vitro* for As bioaccumulation and phytoremediation of water environments. *Environmental Pollutants and Bioavailability*, 35(1), 2205010.
5. UrbaneK Krajnc, A., Senekovič, J., Cappellozza, S., & Mikulic-Petkovsek, M. (2023). The Darker the Better: Identification of Chemotype Profile in Soroses of Local and Introduced Mulberry Varieties with Respect to the Colour Type. *Foods*, 12(21), 3985.
6. Laznik, Ž., Križman, M., Zekič, J., Roškarič, M., Trdan, S., & UrbaneK Krajnc, A. (2023). The Role of Ascorbate–Glutathione System and Volatiles Emitted by Insect-Damaged Lettuce Roots as Navigation Signals for Insect and Slug Parasitic Nematodes. *Insects*, 14(6), 559.
7. UrbaneK Krajnc, A., Bakonyi, T., Ando, I., Kurucz, E., Solymosi, N., Pongrac, P., & Berčič, R. L. (2022). The effect of feeding with central european local mulberry genotypes on the development and health status of silkworms and quality parameters of raw silk. *Insects*, 13(9), 836.