

PROCEEDINGS OF THE

# 20<sup>th</sup> INTERNATIONAL SUNFLOWER CONFERENCE



Novi Sad, Serbia  
June 20-23, 2022

---

Proceedings of the

# 20<sup>th</sup> International Sunflower Conference



**Novi Sad, Vojvodina, Serbia**  
**June 20-23, 2022**

**Sponsored by**



**The International Sunflower Association, Paris, France,**

**In cooperation with**



**The Institute of Field and Vegetable Crops, National  
Institute of Republic of Serbia, Novi Sad, Serbia**

---

---

*Proceedings of the 20<sup>th</sup> International Sunflower Conference*  
Novi sad, Serbia, June 20-23, 2022

**Editors:** Sreten Terzić, Dragana Miladinović

**Editorial committee:**

Dr. Aleksandra Radanović  
Dr. Boško Dedić  
Dr. Dragana Miladinović  
Dr. Igor Balalić

Dr. Nada Grahovac  
Dr. Sandra Cvejić  
Dr. Sonja Gvozdenac  
Dr. Sreten Terzić

**Scientific committee:**

Dr. Dragana Miladinović,  
IFVCNS, Serbia (Chair)  
Dr. Daniel Álvarez, INTA, Argentina  
Dr. Tatiana Antonova, VNIIMK, Russia  
Dr. Kulpash Bulatova, KSRI, Kazakhstan  
Dr. Miguel Cantamutto, INTA, Argentina  
Prof. dr. Jovan Crnobarac, UNS, Serbia  
Dr. Sandra Cvejić, IFVCNS, Serbia  
Dr. Philippe Debaeke, INRA, France  
Dr. Yakov Demurin, VNIIMK, Russia  
Dr. Maria Duca, UASM, Moldova  
Dr. Valentina Encheva, DAI, Bulgaria  
Dr. László Hargitay, Agromag, Hungary  
Dr. Nada Hladni, IFVCNS, Serbia  
Dr. Brent Hulke, USDA ARS, USA  
Dr. Chao-Chien Jan, China  
Dr. Siniša Jocić, IFVCNS, Serbia  
Dr. Yalcin Kaya, TUHM, Turkey  
Prof. dr. Renate Horn, UR, Germany  
Dr. Nicolas Langlade, INRA, France  
Dr. Kateryna Makliak, NAAS, Ukraine  
Prof. dr. Stevan Maširević, Serbia  
Dr. Vladimir Miklič, IFVCNS, Serbia  
Dr. Leire Molinero Ruiz, CSIC, Spain  
Dr. Sujatha Mulpuri, DOR ICAR, India  
Dr. Stéphane Muñoz, INRA, France  
Dr. Maria Pacureanu-Joita, NARDI, Romania  
Dr. Begoña Pérez-Vich, CSIC, Spain  
Etienne Pilorge, Terres Inovia, France  
Prof. dr. Loren Rieseberg, UBC, Canada  
Dr. Gerald Seiler, USDA ARS, USA  
Academician Dragan Škorić, SANU, Serbia  
M.Sci. Mariano Sposaro, Syngenta, Argentina  
Dr. Sreten Terzić, IFVCNS, Serbia  
Dr. Gian Paolo Vannozzi, UDSU, Italy  
Dr. Felicity Vear, France  
Dr. Leonardo Velasco, CSIC, Spain  
Prof. dr. Jun Zhao, IMAU, China

**Organizing committee:**

Chair: Dr. Vladimir Miklič  
Co-chair: Dr. Siniša Jocić  
Dr. Dragana Miladinović  
Dr. Ana Marjanović Jeromela  
Dr. Jelena Ovuka  
Dr. Sreten Terzić  
Dr. Sandra Cvejić  
Dr. Sonja Gvozdenac  
Dr. Goran Malidža  
Dr. Nada Hladni  
Dr. Nenad Dušanić  
Dr. Igor Balalić  
Dr. Velimir Radić  
Dr. Aleksandra Radanović  
Dr. Sonja Tančić Živanov  
Dr. Boško Dedić  
Dr. Milan Jocković  
Dr. Nada Grahovac  
Dr. Željko Milovac  
MSc. Zvonimir Sakač  
MSc. Brankica Babec  
MSc. Nemanja Ćuk  
MSc. Dragana Savin  
BSc. Nada Lečić  
BSc. Siniša Prole  
BSc. Branislav Ostojić  
BSc. Goran Jokić  
BSc. Ilija Radeka  
BSc. Daliborka Butaš  
BSc. Miloš Krstić  
BSc. Nedeljko Klisurić

---

## **The International Sunflower Association Board of Directors:**

Dr Vladimir MIKLIČ, Serbia (President & Representative of ISA Sponsors)

Mr Etienne PILORGE, France (Secretary-Treasurer)

Dr Yakov DEMURIN, Russia

Dr Maria DUCA, Moldova

Dr Valentina ENCHEVA, Bulgaria

Dr Laszlo HARGITAY, Hungary

Dr Brent HULKE, USA

Dr Maria JOITA-PACUREANU, Romania

Dr Yalcin KAYA, Turkey

Dr Nicolas LANGLADE, France

Dr Stevan MAŠIREVIĆ, Serbia

Dr Mulpuri SUJATHA, India

Dr Gian Paolo VANNOZZI, Italy

Dr Leonardo VELASCO, Spain

Pr Jun ZHAO, PR China

Dr Katerina Makliak, Ukraine

Guillermo Pozzi (as subsidiary of Carlos Feoli) Argentina

The proceedings of the 20<sup>th</sup> International Sunflower Conference contain 153 contributions from scientists of 30 countries. They include plenary lectures, oral talks and regular communications presented with posters, among which, selected contributions were emphasized with short oral talks. The manuscripts are classified by research areas in ten separate sections. They offer a thorough review of the current state of the art of sunflower research and production around the world. The Organizing Committee is grateful to Tanja Vunjak and Aleksandar Vojisavljević for their excellent editorial assistance in the preparation of these Proceedings.

ISC2022 Organizing committee



## Conference program

Sunday, 19 June

16.00-21.00	Registration
19.00-21.00	Welcome Reception

Monday, 20 June

8.00-17.00	Registration	
9.00-9.30	Opening Ceremony	
9.30- 10.15	<b>Invited talk</b> Section 1: Dr. Felicity Vear (France)	
10.15-11.00	Coffee break	
11.00-12.00	<b>Section 1: Breeding – New/old breeding goals and challenges</b>	<b>Section 2: Oils and proteins – Innovations for increased quality and feedstock supply</b>
	<b>Oral and short oral presentations</b>	<b>Oral and short oral presentations</b>
12.00-13.30	Lunch	
13.30-14.30	<b>Invited talks</b> Section 3: Dr. C.C. Jan (China) Section 4: Dr. Sreten Terzić (IFVCNS, Serbia)	
14.30-15.00	Coffee break	
15.00-16.00	<b>Section 3: Confectionery sunflower – Emerging crop</b>	<b>Section 4: Genetic resources – Investment for the future</b>
	<b>Oral and short oral presentations</b>	<b>Oral and short oral presentations</b>
16.00-17.00	<b>Poster session</b> – Sections 1, 2, 3, 4	
18.00-21.00	Novi Sad and Petrovaradin fortress tour	

## Tuesday, 21 June

8.30-17.00	Registration	
<b>9.30-10.30</b>	<b>Invited talks</b> Section 5: Dr. Leire Molinero Ruiz (CISC, Spain) Section 6: Dr. Philippe Debaeke (INRAE, France)	
10.30-11.00	Coffee break	
<b>11.00-12.00</b>	<b>Section 5: Biotic stress resistance – New and emerging pests and diseases</b>	<b>Section 6: Crop production and modeling – Yield stability in changing environment</b>
	<b>Oral and short oral presentations</b>	<b>Oral and short oral presentations</b>
12.00-13.30	Lunch	
<b>13.30-14.30</b>	<b>Invited talks</b> Section 7: Dr. Nicolas Langlade (INRAE, France) Section 8: Etienne Pilorgé (Terres Inovia, France)	
14.30-15.00	Coffee break	
<b>15.00-16.00</b>	<b>Section 7: Abiotic stress resistance – Challenges of changing environment</b>	<b>Section 8: Economy and market – Trends and prospects</b>
	<b>Oral and short oral presentations</b>	<b>Oral and short oral presentations</b>
<b>16.00-17.00</b>	<b>Poster session – Sections 5, 6, 7, 8</b>	

## Wednesday, 22 June

8.30-17.00	Registration	
<b>9.30-10.30</b>	<b>Invited talks</b> Section 9: Dr. Stéphane Muños (INRAE, France) Section 10: Dr. Nicole Creux (FABI, South Africa)	
10.30-11.00	Coffee break	
<b>11.00-12.00</b>	<b>Section 9: Broomrape – Constant challenge</b>	<b>Section 10: Bees and seeds – Exploring new venues for increased yield and seed production</b>
	<b>Oral and short oral presentations</b>	<b>Oral and short oral presentations</b>
12.00-13.30	Lunch	
<b>13.30-14.30</b>	<b>Panel: Sunflower in a changing environment – Trends and prospects</b>	
14.30-15.00	Coffee break	
<b>14.30-15.30</b>	<b>Poster session – Sections 9, 10</b>	
15.00-16.30	ISA Assembly	
16.30-17.00	Closing ceremony	
20.00-24.00	Gala Dinner Pustavoit Award Presentation Ceremony IFVCNS Best Poster Award Presentation	

## Thursday, 23 June

9.00-15.00	Field day
------------	-----------



---

# Table of contents

## PLENARY

<b>Old and New breeding goals and challenges</b>	
Felicity Vear .....	1
<b>Sunflower improvement in seed and oil quality in Russia</b>	
Yakov Demurin .....	8
<b>Confectionery sunflower as an emerging crop</b>	
Chao-Chien Jan .....	13
<b>From conservation to introgression breeding - from conservation to introgression breeding</b>	
Sreten Terzić .....	18
<b>Biological control agents against sunflower pathogens</b>	
Carmen Gómez-Lama Cabanás, Pedro Miranda-Fuentes, Jesús Mercado-Blanco, Mercedes Romero-Cuadrado, Leire Molinero-Ruiz .....	25
<b>New cropping systems and growing environments for sunflower: consequences on target traits and ideotypes</b>	
Philippe Debaeke .....	26
<b>Prediction of sunflower tolerance to drought using quantitative genetics and crop modelling</b>	
Langlade Nicolas, Casadebaig Pierre, Gosseau Florie, Mangin Brigitte, The SUNRISE consortium .....	27
<b>Sunflower in the global vegetable oil system: situation, specificities and perspectives</b>	
Etienne Pilorgé .....	28
<b>Resistance to <i>Orobanche cumana</i>: “We will keep on fighting until the end”</b>	
Muños Stéphane .....	29
<b>The delicate balancing act of climate control during flowering, pollination and seed development in sunflower</b>	
Nicky Creux, Carine Marshall, Uyabongeka Memela, Phrasia Mapfumo, Stacey Harmer .....	30

## ORAL TALKS

<b>Applying genomic tools to accelerate and facilitate downy mildew resistance breeding in sunflower</b>	
Guojia Ma, Xuehui Li, Lili Q .....	31
<b>¿Does white rot resistance penalize seed-yield in sunflower?</b>	
M Antonella Giussani, Fernando Castaño, Santiago G. Delgado .....	35
<b>The impact of the Ahas1-4 herbicide tolerance allele over different agronomic traits in sunflower</b>	
Emiliano Altieri, Raquel Sensolini, Mariano Sposaro, Federico Bock, Mariano Bulos .....	40
<b>Developing and Comparing the Yield Potential of Single Cross and Three Way Cross Sunflower Hybrids for Uganda Condition.</b>	
Walter O. Anyanga, Pius Elobu .....	41
<b>A multi-year survey on sunflower meal quality produced in france</b>	
Sylvie Dauguet, Elodie Tormo, Mohammed Krouti, Alain Quinsac .....	48
<b>Improvement of the nutritional value of sunflower meal by sifting technology</b>	
Alain Quinsac, Justine Danel, Sylvie Dauguet, Corinne Peyronnet, Mohammed Krouti, Patrick Carré, François Brionnet, Maria Vilarino .....	49
<b>Confectionery sunflower in Serbia</b>	
Nada Hladni, Ranko Romanić, Brankica Babec, Siniša Jocić, Vladimir Miklič, Veljko Petrović,	

Dragana Miladinović .....	50
<b>Recent situation of confectionery sunflower production in Turkey</b>	
Yalcin Kaya .....	55
<b>A germplasm collection of confectionery sunflower landraces from Spain</b>	
Leonardo Velasco, José M. Fernández-Martínez, Begoña Pérez-Vich .....	59
<b>Stability in seed yield over years in confectionery sunflower</b>	
Veli Pekcan, Mehmet Sezgin, Hatice Tezcan, Mehmet Ibrahim Yilmaz, Necmi Beser, Goksel Evcı, Yalcin Kaya .....	68
<b>Current status of sunflower genetic resources in India</b>	
M.Y. Dudhe, M. Sujatha, H.P. Meena, K. Alivelu, A. Vishnuvardhan Reddy .....	72
<b>Resistances to <i>Orobanche cumana</i> by exploiting helianthus genetic diversity.</b>	
Chabaud Mireille, Folletti Tifaine, Boniface Marie-Claude, Pérez-Vich- Begoña, Legendre Alexandra, Delavault Philippe, Simier Philippe, Pouvreau Jean-Bernard, Velasco Leonardo, Muños Stéphane .....	73
<b>Genomic prediction of yield tolerance to drought in sunflower genetic resources</b>	
Duhnen Alexandra, Blanchet Nicolas, Boniface Marie-Claude, Pouilly Nicolas, Langlade Nicolas, Mangin Brigitte .....	74
<b>Lumisena™: A new seed treatment fungicide for downy mildew control in sunflower</b>	
Shevchuk Oleg, Fernandes Nilceli, Papageorgiou Kalliopi, Troisi Marco .....	75
<b>Downy Mildew of Sunflower – Innovative control with the seed applied technologies</b>	
<b>PLENARIS™ and Acibenzolar-S-Methyl</b>	
Domenico di Bianco, Jennifer Foster, Franz Brandl, Julien Fourmont .....	76
<b>Viballa™: A new effective herbicide for broadleaf weed control in sunflower crops</b>	
Salas Maria, Apostolidis Vasilis .....	77
<b>Sunflower yield prediction based on high resolution satellite imagery</b>	
Branislav Pejak, Oskar Marko, Tatjana Lončar-Turukalo, Predrag Lugonja, Nataša Ljubičić, Vladimir Crnojević .....	78
<b>Organic foliar fertilization of sunflower enhanced sunflower yield attributes and seed yield in the humid tropics</b>	
Victor Olowe, James Fadeyi, Patience Odueme, Olabisi Somefun .....	79
<b>Genetic, transcriptomic and physiological characterization of cold tolerance in sunflower</b>	
Jean Lecomte, Nicolas Langlade, Nicolas Pouilly, Nicolas Blanchet .....	80
<b>Sunflower drought: QTLs discovery in semi controlled conditions</b>	
Marlene Mazas, Virginie Mirleau-Thebaud .....	81
<b>Genetic control of sunflower metabolome in a dry agronomic environment</b>	
Marco Moroldo, Annick Moing, Stéphane Bernillon, Vincent Segura, Gabriela Bindea, Nicolas Blanchet, Nicolas Langlade, SUNRISE consortium .....	86
<b>Commercial launch of A.I.R.™ in Europe, a new herbicide-tolerant production system for Sunflower from Syngenta</b>	
Gilles Grée, Attila Kovács .....	87
<b>Cultural practices of sunflower in France analysis and rooms for progress</b>	
Lecomte Vincent, Martin Monjaret Claire .....	88
<b>Sunflower bird damage: is the research up to the challenges?</b>	
Christophe Sausse, Corentin Barbu, Alice Baux, Sonia B. Canavelli, Page E. Klug, Fernando Pellegrini, Sebastian G. Zuil .....	89
<b>Applied research &amp; development for French sunflower –priorities to contribute to France’s national protein strategy</b>	
David Gouache, Vincent Lecomte, Christophe Sausse, Dominique Wagner, Sylvie Dauguet, Claire Martin-Monjaret .....	93
<b>Novel Sources of Resistance to <i>Orobanche cumana</i> Wallr. in Sunflower</b>	
Irina Čalić, Anna Finkers-Tomczak, Rui Peng-Wang, Saskia Jacobs-Oomen, Evert-Jan Blom, Roy Gorkink, Marcel van Verk, Mireille Chabaud, Martin de Vos, Arjen van Tunen, Stephane Muños, Wilco Ligterink .....	94



---

<b>miPEPs: new tools to study and control the sunflower broomrape</b>	
Sabine Tourneur, Jean-Philippe Combier, Stéphane Munos, Thomas Laurent, Philippe Delavault .....	95
<b>Some characteristics of <i>Orobanche cumana</i> from different countries</b>	
Maria Duca, Angela Port, Steliana Clapco .....	96
<b>The genetic interaction between sunflower inbred lines in the process of developing <i>Orobanche cumana</i> resistance hybrids</b>	
Onisan Emilian, Petrescu Irina.....	97
<b>Insect pollination is necessary to achieve maximum seed yield and oil content in sunflower, but a low bee density is enough</b>	
Stan Chabert, Christopher Sénéchal, André Fougeroux, Olivier Geist, Vincent Guillemard, Solenne Leylavergne, Constance Malard, Jérémy Pousse, Gabriel Carré, Édith Caumes, Charlotte Cenier, Alain Treil, Bernard E. Vaissière.....	98
<b>Contamination of Sunflower Seeds by Fungi and Its Control Using Fungicide Treatments</b>	
Mandela E. Addrach, Yuan Zhang, Jian Zhang, Lin Liu, HongYou Zhou, Jun Zhao .....	103
<b>Association studies and marker development for the fertility restorer gene <i>RF1</i> in sunflower</b>	
Renate Horn, Aleksandra Radanovic, Lena Fuhrmann, Yves Sprycha, Sonia Hamrit, Milan Jockovic, Dragana Miladinovic, Constantin Jansen.....	104

## SHORT ORAL TALKS

<b>Feature selection and performance assessment of machine learning algorithms for sunflower oil yield prediction</b>	
Sandra Cvejić, Olivera Hrnjaković, Milan Jocković, Aleksandar Kupusinac, Ksenija Doroslovački, Ilija Radeka, Siniša Jocić, Dragana Miladinović, Vladimir Miklič .....	105
<b>Development of magic populations for sunflower disease resistance breeding</b>	
Matías Domínguez, Carla Filippi, Juan Montecchia, Mónica Fass, Facundo Quiroz, Daniel Álvarez, Ruth Heinz, Verónica Lia, Julio González, Norma Paniego .....	106
<b>Comparison between the predicted performances of simulated sunflower breeding populations and the predicted breeding values of realized progenies.</b>	
Alix Allard, Ignacio Navarro .....	107
<b>Oil extraction from sunflower seeds assisted by pulsed electric field pre-treatment</b>	
Ivan Shorstkii, Evgeny Koshevoi, Meysam S. Mirshekarloo .....	108
<b>Time Domain-NMR with chemometric analysis : An alternative tool for determination protein content in sunflower seeds</b>	
Loudiyi Mohammed, Le Dorze François, Fintz Christine, Lem Patricia.....	109
<b>Extraction yield obtained by pressing sunflower seed</b>	
Ranko Romanić, Tanja Lužaić, Nada Grahovac, Sandra Cvejić, Siniša Jocić, Snežana Kravić, Zorica Stojanović.....	110
<b>Response of Seed Yield and Seed Size to Plant Density in Two Confectionary Sunflower Hybrids</b>	
Monica López Pereira, Deborah Rondanini, Tomas Pueta, Fernando Turienzo, Ezequiel Barreto.....	111
<b>Investigation and comparison of geometric characteristics of oily and non-oily sunflower hybrid seeds</b>	
Tanja Lužaić, Ranko Romanić, Nada Grahovac, Nada Hladni, Zvonimir Sakač, Snežana Kravić, Zorica Stojanović .....	115
<b>Morpho-chemical characterization of new confectionary sunflower (<i>Helianthus annuus</i> L.) genotypes from Argentina</b>	
Rebeca Sandrinelli Tesán, Daniel Alvarez, Mercedes Silva, Roxana Aguilar, Adriana Pazos, Mónica Balzarini, María José Martínez.....	116

<b>Secretory tissues of discs flowers in wild <i>Helianthus L.</i> species</b>	
Jelena Jocković, Sreten Terzić, Lana Zorić, Dragana Miladinović, Jadranka Luković .....	117
<b>Resistance of wild <i>Helianthus</i> species to the prevailing Chinese broomrape (<i>Orobanche cumana L.</i>) races</b>	
Min Chang, Chao-Chien Jan .....	118
<b>The French Sunflower Genebank</b>	
Tapy Camille, Boniface Marie-Claude.....	122
<b>Flow cytometrical characterization in sunflower genus</b>	
Meryem Şahin, Gulsemin Savas Tuna, Metin Tuna, Yalcin Kaya.....	123
<b>Preliminary study on the effect of different plant resistance inducers against sunflower downy mildew (<i>Plasmopara halstedii</i>)</b>	
Ahmed Ibrahim Alrashid Yousif, Pratik Doshi, György Turóczi, Katalin Körösi, Nisha Nisha, Rita Bán.....	127
<b>Innovative “Attract &amp; kill” strategy for controlling wireworms in sunflower</b>	
Sonja Gvozdenac, Željko Milovac, Stefan Vidal, Jelena Ovuka, Vladimir Miklič, Sandra Cvejić, Brankica Babec.....	128
<b>Occurrence of <i>Plasmopara halstedii</i> (Sunflower downy mildew) pathotypes in Hungary</b>	
Rita Bán, Attila Kovács, Nisha Nisha, Katalin Körösi, Zoltán Pálincás, Mihály Zalai, Ahmed Ibrahim Alrashid Yousif, Mihály Perczel, József Kiss.....	129
<b>Evolution of sunflower downy mildew in France</b>	
Penaud Annette, Perrot Sophie, Boniface Marie-Claude, Pauchet-Mattler Isabelle, Delos Marc, Bret-Mestries Emmanuelle.....	130
<b>Sunflower oil yield responses to wide inter-row spacing</b>	
Monica López Pereira, Andrés Paterniti, Edmundo Ploschuk.....	139
<b>New approaches in phenotype prediction – Machine learning techniques</b>	
Milan Jocković, Sandra Cvejić, Siniša Jocić, Ilija Radeka, Jelena Jocković, Aleksandra Radanović, Sreten Terzić, Boško Dedić.....	140
<b>Assessment of the biofumigation potential of <i>Brassica</i> species against Sunflower <i>Verticillium Wilt</i> (<i>Verticillium dahliae</i>) – A field-experiment approach</b>	
Ait Kaci Ahmed Neïla, Desplanques Jérémy, Galaup Benoit, Dechamp-Guillaume Grégory, Seassau Célia .....	141
<b>The effects of climate change on sunflower yield in the Konya basin of Turkey</b>	
Hüdaverdi Gürkan, Nilgün Bayraktar, Gerrit Hooogenboom .....	142
<b>Sensitivity of different herbicide-tolerant sunflower hybrids to selected ALS-inhibiting herbicides</b>	
Goran Malidža, Miloš Rajković, Siniša Jocić, Sandra Cvejić .....	143
<b>The effect of climatic changes – hail and storm on sunflower hybrids – Constanta county, Dobrogea area, Romania</b>	
Dumitru Manole, Ana Maria Giumba, Laurentiu Luca Ganea, Viorel Ion .....	144
<b>Public and Private Partnership in evaluating and commercializing of sunflower hybrids in Uganda</b>	
Walter O. Anyanga, Pius Elobu.....	154
<b>Types of sunflower hybrids registered in Serbia</b>	
Jasna Savić, Danijela Stojanović.....	155
<b>The environmentally safe method of control of broomrape (<i>Orobanche cumana wallr.</i>) parasitising on sunflower</b>	
Evgeniy Strelnikov, Tatiana Antonova, Lyudmila Gorlova, Victoria Trubina .....	156
<b>Herbicide seed treatment in Clearfield® plus sunflower against early <i>Orobanche cumana</i> attack</b>	
Matthias Pfenning, Juan Manuel Contreras, Rosa Gimenez .....	163

---

<b>Sunflower broomrape – Update on virulence in Serbia</b>	
Boško Dedić, Ilija Radeka, Siniša Jocić, Dragana Miladinović, Sandra Cvejić, Milan Jocković, Aleksandra Radanović, Vladimir Miklič.....	164
<b>Planting date and environments affect sunflower development, yield and Sclerotinia head rot progression</b>	
Mapfumo P, Wilkens M, Swanevelder D, Archer E, Creux NM. ....	165
<b>Bee vectoring of biologicals in sunflowers as a crop protection tool</b>	
John C. Sutton, Sherri Tedford, Gerardo Suazo, Christoph Lehnen, Sreten Terzić, Michael Wunsch, Venkataramana Chapara.....	166
<b>The different invigoration techniques for sunflower seeds</b>	
Dušica Jovičić, Jelena Ovuka, Zorica Nikolić, Gordana Petrović, Dragana Marinković, Milan Stojanović, Ana Marjanović-Jeromela.....	167
 <b>POSTERS - Section 1: Breeding</b>	
<b>Correlations and path analyses of some sunflower breeding parameters</b>	
Velimir Radić, Igor Balalić, Milan Jocković, Nada Hladni, Miloš Krstić, Siniša Jocić, Vladimir Miklič .....	169
<b>Genome-wide association studies reveal new genetic loci associated with fatty acid composition in Sunflower</b>	
Alina Chernova, Elena Martynova.....	170
<b>Mapping of loci associated with tocopherol composition using genotyping by sequencing approach in sunflower</b>	
Rim Gubaev, Stepan Boldyrev, Alina Chernova, Elena Martynova, Tatyana Kovalenko, Tatyana Peretyagina, Svetlana Goryunova, Denis Goryunov, Cecile Ben, Laurent Gentzbittel, Philipp Khaitovich, Yakov Demurin .....	171
<b>Adaptability potential of new sunflower hybrids under the conditions of Dobrudzha region</b>	
Galim Georgiev .....	172
<b>Correlation analysis for seed yield and its component traits in experimental sunflower IMI resistant hybrids</b>	
D. Valkova.....	173
<b>Components related to higher head diameter, heterosis and type of inheritance in oil seed sunflower (<i>Helianthus annuus</i> L.)</b>	
Georgi Georgiev, Nina Nenova, Galim Georgiev, Daniela Valkova, Penka Peevska, Valentina Encheva .....	174
<b>LSFH-171: A high yielding, downy mildew resistant sunflower hybrid suitable for the different agro-climatic zones of Indian conditions</b>	
M. K. Ghodke, M.Y. Dudhe, A.M. Misal, M. Sujatha .....	175
<b>New type of experimental sunflower hybrids Su-IMI plus</b>	
Anton Florin Gabriel.....	176
<b>New form cultivated sunflower (<i>Helianthus annuus</i> L.) with resistance to the herbicides pulsar and express</b>	
Michail Christov, Miroslava Hristova-Cherbadzhi.....	177
<b>Identification of a novel mutation in a stearyl-acyl carrier protein desaturase gene associated with enhanced stearic acid levels in sunflower seed</b>	
Hirohisa Saga, Sayuri Kitagawa .....	181
<b>Imidazolinone-induced male sterility in sunflower: a novel strategy for hybridization</b>	
Marisa Della Maddalena, Germán Zuzul, Oscar Marques, José María Bruniard, Graciela Nestares, Ana Ochogavía .....	182
<b>The first report on efficient CRISPR-based protocol for sunflower</b>	
Kubilay Yildirim, İlkay Sevgen, Ankica Kondić-Špika, Sandra Cvejić, Siniša Jocić, Dragana Miladinović .....	186

---

---

POSTERS - Section 2: Oils and proteins

**Influence of pulsed electrical discharge, hydrostatic pressure and temperature on rheological properties of sunflower cake during oil pressing**  
Ivan Shorstkii, Evgeny Koshevoi, Maxim Sosnin ..... 187

**A Novel Method of Determination of Individual Oil Content in Sunflower and Flaxseed Oil Blends**  
Marko Ilić, Kristian Pastor, Ana Marjanović Jeromela, Ranko Romanić, Vladimir Miklič, Dura Vujić, Marijana Ačanski..... 188

**Dry fractionation process of sunflower meal for the production of protein and phenolic compounds enriched fractions**  
Oscar Laguna, Abdellatif Barakat, Hadil Alhamada, Erwann Durand, Bruno Baréa, Frédéric Fine, Pierre Villeneuve, Morgane Citeau, Sylvie Dauguet, Jérôme Lecomte..... 189

**Fatty acid characterization of sunflower breeding materials at the IFVC**  
Nada Grahovac, Zvonimir Sakač, Siniša Jocić, Sandra Cvejić, Vladimir Miklič ..... 190

**Importance of tocopherol in modification the quality of sunflower oil**  
Dragan Škorić, Zvonimir Sakač, Yakov Demurin ..... 191

**Enzymatic release of caffeic acid from sunflower meal and improvement of its antioxidant activity in emulsion by lipophilisation**  
Oscar Laguna, Elise Odinot, Alexandra Bisotto, Bruno Baréa, Pierre Villeneuve, Jean-Claude Sigoillot, Eric Record, Craig B. Faulds, Frédéric Fine, Sylvie Dauguet, Alain Quinsac, Laurence Lesage-Meessen, Anne Lomascolo, Jérôme Lecomte ..... 192

**Amino acid profile in sunflower seeds**  
Le Dorze François, Seguineau Armelle, Loudiyi Mohammed, Fintz Christine, Lem Patricia... 193

POSTERS - Section 3: Confectionery sunflower

**Assessment of stability of seed oil and protein content in confectionery hybrids using the apple AMMI analysis**  
Nada Hladni, Samet Salgam, Miroslav Zorić, Dragana Miladinović, Siniša Jocić, Ana Marjanović Jeromela, Sreten Terzić, Milan Jocković, Sandra Cvejić, Boško Dedić, Aleksandra Radanović, Zvonimir Sakač, Velimir Radić, Nenad Dušanić, Brankica Babec, Nemanja Ćuk, Jelena Ovuka, Nada Grahovac, Sonja Gvozdenac, Vladimir Miklič ..... 194

**Polyphenols and flavonoids contents in seed cake from Serbia confectionary sunflower (*Helianthus annuus* L.)**  
Zorica Stojanović, Nada Grahovac, Snežana Kravić, Ana Đurović, Ranko Romanić..... 195

POSTERS - Section 4: Genetic resources

**Root xylem anatomy of the wild and cultivated sunflower**  
Jadranka Luković, Aleksandra Radanović, Anna Galinski, Dunja Karanović, Lana Zorić, Jelena Jocković, Kerstin A. Nagel, Dragana Miladinović ..... 196

**Fifty years of collecting wild *Helianthus* species for cultivated sunflower improvement**  
Gerald Seiler, Laura Fredrick Marek, Tom Gulya ..... 197

**Massive haplotypes underlie adaptive variation in wild sunflowers**  
Marco Todesco, Gregory L. Owens, Natalia Bercovich, Jean-Sébastien Légaré, Shaghayegh Soudi, Dylan O. Burge, Kaichi Huang, Katherine L. Ostevik, Emily B. M. Drummond, Ivana Imerovski, Kathryn Lande, Mariana A. Pascual, Winnie Cheung, S. Evan Staton, Stéphane Muñoz, Rasmus Nielsen, Lisa A. Donovan, John M. Burke, Sam Yeaman, Loren H. Rieseberg..... 201

**Study of the reaction of *Helianthus debilis* accessions to *Phomopsis/ Diaporthe helianthi* Munt.-Cvet.**  
Maria Petrova, Daniela Valkova, Valentina Encheva..... 202

<b>Evaluation of sunflower inbred lines resistance to <i>Macrophomina phaseolina</i> using different inoculation methods</b>	
Nemanja Ćuk, Sandra Cvejić, Velimir Mladenov, Brankica Babec, Boško Dedić, Vladimir Miklič, Siniša Jocić .....	203
<b>Click beetles monitoring using pheromone traps in Serbia</b>	
Željko Milovac, Sonja Gvozdenc, Filip Franeta, Petar Čanak.....	204
<b>Fungicide tolerance of <i>Plasmopara halstedii</i> (sunflower downy mildew) to Mefenoxam in Hungary</b>	
Nisha Nisha, Attila Kovács, Katalin Körösi, Rita Bán, Ahmed Ibrahim Alrashid Yousif, Arbnora Berisha, Mihály Perczel.....	205
<b>Colonization of sunflower seed with <i>Alternaria alternata</i></b>	
Dragana Milošević, Maja Ignjatov, Vladimir Miklič, Maja Karaman, Zorica Nikolić, Gordana Tamindžić, Boško Dedić .....	206
<b>New races of the sunflower downy mildew pathogen (<i>Plasmopara halstedii</i>) in Bulgaria</b>	
Valentina Encheva, Maria Petrova, Neno Nenov, Galin Georgiev, Nina Nenova, Daniela Valkova, Penka Peevska, Georgi Georgiev.....	207
<b><i>Cadophora helianthi</i>, a new fungus affecting sunflowers in Eastern Europe</b>	
David Gramaje, Alberto Martín-Sanz, Carmen Berlanas, Leire Molinero-Ruiz .....	208
<b><i>Botrytis cinerea</i> as causal agent of sunflower seed grey mould</b>	
Maja Ignjatov, Dragana Milošević, Vladimir Miklič, Boško Dedić, Gordana Tamindžić, Dragana Bjelić, Žarko Ivanović.....	209
<b><i>Plasmopara halstedii</i> race 735 in Serbia</b>	
Boško Dedić, Stevan Maširević, Siniša Jocić, Sandra Cvejić, Milan Jocković, Dragana Miladinović, Aleksandra Radanović, Vladimir Miklič.....	210
<b>Dissection of the downy mildew genes cluster on chromosome 8</b>	
Paris Clémence, Rousseau Jean-Christophe .....	211
<b>Tolerance of NS-sunflower genotypes to charcoal rot</b>	
Sonja Tančić Živanov, Boško Dedić, Sandra Cvejić, Vladimir Miklič, Miroslav Zorić.....	212
<b>New races of <i>Puccinia helianthi</i> schwein on sunflower in the Russian federation</b>	
Nina Araslanova, Tatiana Antonova, Ekaterina Lepeshko, Tatiana Usatenko, Yulya Pitinova, Maria Iwebor, Svetlana Saukova.....	213
<b>The identification of sunflower resistance genes to downy mildew</b>	
Svetlana Ramazanova, Evgeny Badyanov, Saida Guchetl.....	214
<b>Changes in the antioxidant enzyme activity levels of sunflower (<i>Helianthus annuus</i> L.) inoculated by <i>Plasmopara halstedii</i> (sunflower downy mildew) and treated with Azadirachtin (Neemazal t/s)</b>	
Kevein Ruas Oliveira, Katalin Körösi, Pratik Doshi, Nisha Nisha, Ahmed Ibrahim Alrashid Yousif, György Turóczy, Priscila Lupino Gratão, Rita Bán .....	215
<b><i>Alternaria</i> on sunflower in regions of the Russian federation: species and their pathogenicity</b>	
Maria Iwebor, Tatiana Antonova, Nina Araslanova, Svetlana Saukova .....	216
<b>Races and oomyceticide tolerances of <i>Plasmopara halstedii</i> in Argentina</b>	
Ana Laura Martínez, María Eugenia Bazzalo, Norma I. Huguet, Amelia Bertero, Ignacio Erreguerena, Ariel Jesús Faberi, Macarena Petrucelli, Jonathan Bannister, Franco Di Giano, Marisa Della Maddalena, Silvana Piubello, Alicia Carrera, Facundo Quiroz .....	217
<b>Climate risk of the Argentine pampas region regarding the release of <i>Diaporthe helianthi</i> ascospores</b>	
Corró Molas A., Edwards Molina J., Therisod G., Colombo D., Martínez M.I., Bilbao A., Bertero A., Moschini R.C .....	218

---

**Alternaria leaf spot of sunflower in regions of the Russian federation: fungal species and their pathogenicity**

Maria Iwebor, Tatiana Antonova, Nina Araslanova, Svetlana Saukova ..... 219

**POSTERS - Section 6: Crop production and modeling**

**Agronomic attribute and stability of new exotic sunflower hybrids in Iran**

Mehdi Ghaffari, Bahram Alizadeh, Hossein Sadeghi, Siamak Kolbadi, Abbasali Andarkhor, Malihe Homayonifar, Ahmad Kalantar Ahmadi ..... 223

**Sunflower seed oil content depending on the seedling type**

Jelena Ovuka, Sonja Gvozdenac, Dušica Jovičić, Miloš Krstić, Daliborka Butaš, Vladimir Miklič ..... 224

**Determination of yield performances of IMI type sunflower (*Helianthus annuus* L.) hybrids resistant to broomrape and downy mildew**

Ibrahim Mehmet Yilmaz, Veli Pekcan, Samet Sağlam, Kadirhan Tekcan, Guray Dinler, Goksel Evci ..... 225

**The influence of sowing date on yield and quality of NS sunflower hybrids**

Jovan Crnobarac, Igor Balalić, Dragana Latković, Goran Jaćimović ..... 226

**The effect of legumes and sunflower intercropping on soil compaction**

Brankica Babec, Nada Hladni, Jovan Crnobarac, Bojan Vojnov, Milorad Živanov, Srđan Šeremešić ..... 227

**Importance of Halauxifen-methyl for integrated weed management in sunflower, with special emphasis on the control of resistant common ragweed to ALS inhibitors**

Goran Malidža, Maria Salas, Miloš Rajković, Notter Jean-Sébastien ..... 228

**SREG model evaluation of sunflower hybrids in South-East Europe**

Milan Jocković, Sandra Cvejić, Siniša Jocić, Dragana Miladinović, Velimir Radić, Vladimir Miklič, Jelena Ovuka, Ana Marjanović-Jeromela ..... 229

**Study on important indices in the seeds of some sunflower hybrids and their correlation**

Nina Nenova, Daniela Valkova ..... 230

**Feasibility of double cropping system with Camelina and sunflower in Serbia**

Ana Marjanović Jeromela, Sandra Cvejić, Siniša Jocić, Jovan Crnobarac, Zlatica Miladinov, Goran Malidža, Miloš Rajković, Željko Milovac, Dušan Dunderski, Igor Balalić, Petar Čanak, Andrea Monti, Federica Zanetti ..... 231

**The improvement of sunflower crop technology in Dobrogea under climate changes**

Vasile Jinga, Dumitru Manole, Ioan Radu, Ana Maria Giumba, Lorena-Roxana Gurau ..... 232

**How to combine environmental indicators for characterizing and clustering variety testing trials? Application to sunflower in France**

Amélia Landré, Pierre Casadebaig, Arnaud Gauffreteau, Nicolas Augis, Christine Fintz, Emmanuelle Bret-Mestries, Philippe Debaeke ..... 237

**Mapping sunflower areas using high resolution sentinel-2 images**

Predrag Lugonja, Miloš Pandžić, Sanja Brdar, Oskar Marko, Vladan Minić, Nataša Ljubičić, Vladimir Crnojević ..... 241

**Sunflower and climate changes: adaptation and mitigation potential from case study in RN Macedonia**

Zoran Dimov, Ordan Cukaliev, Dusko Mukaetov, Vjekoslav Tanaskovic ..... 245

**Planting date and environments affect sunflower development, yield and *Sclerotinia* head rot progression**

Mapfumo P, Wilkens M, Swanevelde D, Archer E, Creux NM ..... 249



---

POSTERS - Section 7: Abiotic stress resistance

**Mining root traits for sunflower drought tolerance improvement by use of an automated phenotyping platform**

Aleksandra Radanović, Anna Galinski, Milan Jocković, Sandra Cvejić, Sreten Terzić, Siniša Jocić, Dragana Miladinović, Fabio Fiorani, Kerstin A. Nagel..... 250

**Climate crops Centre of excellence – bringing innovation in sunflower breeding for climate resilience**

Dragana Miladinović, Ankica Kondić-Špika, Ana Mrajanović Jeromela, Goran Bekavac, Sonja Tančić Živanov, Miroslav Zorić, Sandra Cvejić, Sanja Mikić, Bojan Mitrović, Aleksandra Radanović, Boško Dedić, Sonja Gvozdenac, Milan Mirosavljević, Jelena Ovuka, Milan Jocković, Dragana Rajković, Verica Takač, Nemanja Čuk, Miloš Krstić, Nada Hladni, Sreten Terzić, Vladimir Miklič, Siniša Jocić, Jegor Miladinović ..... 251

**Creating climate smart sunflower for future challenges – The SMARTSUN multidisciplinary project**

Aleksandra Radanović, Sandra Cvejić, Jadranka Luković, Milan Jocković, Siniša Jocić, Boško Dedić, Sonja Gvozdenac, Nemanja Čuk, Nada Hladni, Jelena Jocković, Olivera Hrnjaković, Dragana Miladinović..... 252

POSTERS - Section 9: Broomrape

**Chemotropism of *Orobanche cumana***

Anna Krupp, Barbara Bertsch, Otmar Spring ..... 253

**Pathogen development in compatible and incompatible combinations of *Orobanche cumana* and sunflower**

Anna Krupp, Annerose Heller, Otmar Spring ..... 254

**Sunflower resistance to broomrape**

Dejana Panković, Igor Vukelić, Gordana Racić, Mirjana Topić, Dragan Škorić..... 255

**Evaluation of different methods to test the sunflower resistance to broomrape**

Sergey Gontcharov, Julia Scibina, Alexandra Baziz ..... 256

**Aggressiveness of broomrape populations infesting sunflower in different countries**

Maria Duca, Steliana Clapco, Ion Gisca, Aliona Cucereavii, Rodica Martea, Chao Wang ..... 257

**Degree of intra- and interpopulation diversity of some Moldovan**

***O. cumana* populations**

Angela Port, Ana Mutu, Olese Tabara, Ina Bivol..... 258

**Aggressiveness of sunflower broomrape from different countries**

Maria Duca, Steliana Clapco, Ion Gisca, Rodica Martea, Chao Wang..... 259

**Genetic variability of *O. cumana* populations infesting sunflower in different countries**

Maria Duca, Angela Port, Steliana Clapco ..... 260

**ORTOBOX – A toolbox to evaluate sunflower varieties for their resistance to broomrape**

Stéphane Muñoz, Sylvie Ducournau, Nicolas Augis Muriel Archipiano, Marie-Claire Tardin, Pierre Castellanet, Camille Henry, Antoine Mezzarobba, Sophie Pardo, Isabelle Pauchet, Christophe Jestin ..... 261

**Investigation on the resistance of new Bulgarian sunflower hybrids**

**to economically important diseases and the parasite *Orobanche***

Penka Peevska, Miglena Drumeva, Galin Georgiev, Valentina Encheva, Georgi Georgiev..... 262

---

**Broomrape (*Orobanche cumana* Wallr.) control, by developing genetic resistant genotypes in sunflower**

Joita Păcureanu Maria, Rîșnoveanu Luxița, Dan Mihaela, Anton Gabriel,  
Sava Elisabeta, Bran Alexandru ..... 263

**The dynamics of the pathogens which attack sunflower crop in Romania**

Joita Păcureanu Maria, Rîșnoveanu Luxița, Dan Mihaela, Stanciu Danil,  
Sava Elisabeta, Bran Alexandru ..... 264

**BSA-seq identify the resistance Genes for broomrape in Sunflower**

Liu Sheng-Li, Wang Peng, Liu YanTao, Wang Pei-Zheng..... 265

**Anthropogenic evolution of broomrape *Orobanche cumana* wallr., parasitizing on sunflower in the Russian federation**

Tatiana Antonova ..... 266

**POSTERS - Section 10: Bees and seeds**

**Sadik's new CMS conversion method for maintainer inbred lines in sunflower**

El Sayed Sadik ..... 267

**Heliopollen: deciphering the molecular bases of sunflower nectar production in response to drought stress.**

Catrice Olivier, Tapy Camille, Blanchet Nicolas, Hernandes Melissa,  
Langlade Nicolas..... 268

**Unraveling the Mechanism behind Delay Sowing Date to Reduce Occurrence of Sunflower Verticillium Wilt**

JianFeng Yang, Jian Zhang, Yuanyuan Zhang, Hongyou Zhou, Jun Zhao ..... 269

**Towards new solutions for the chemical desiccation of sunflower**

Vladimir Miklič, Jelena Ovuka, Goran Malidža, Branislav Ostojić,  
Velimir Radić, Nenad Dušanić, Siniša Jocić ..... 270

**Growth promoting activity of *Trichoderma* spp. on sunflower seedlings**

Sonja Tančić Živanov, Siniša Jocić, Vladimir Miklič ..... 271

**Seed size and substrate effect on seed germination of inbred sunflower lines**

Miloš Krstić, Jelena Ovuka, Velimir Radić, Sonja Gvozdenac,  
Vladimir Miklič, Velimir Mladenov, Borislav Banjac, Teodora Kukrić ..... 272

## ROOT XYLEM ANATOMY OF THE WILD AND CULTIVATED SUNFLOWER

Jadranka Luković<sup>1\*</sup>, Aleksandra Radanović<sup>2</sup>, Anna Galinski<sup>3</sup>, Dunja Karanović<sup>1</sup>, Lana Zorić<sup>1</sup>,  
Jelena Jocković<sup>1</sup>, Kerstin A. Nagel<sup>3</sup> & Dragana Miladinović<sup>2</sup>

<sup>1</sup>*University of Novi Sad, Faculty of Sciences, Trg D. Obradovica 2, Novi Sad, Serbia,*

<sup>2</sup>*Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad, Serbia,*

<sup>3</sup>*IBG-2: Plant Sciences, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany*

Corresponding author: \*jadranka.lukovic@dbe.uns.ac.rs

### Abstract

The root functionality is affected by numerous factors. One of the main structural parameters, the most important for functionality and adaptability, is xylem organization. Taking into account that sunflower root features have not been directly selected in breeding programs the aim of this research is to determine whether different sunflower genotypes (wild annual species and cultivated genotypes) have influence (i) on the structure of the xylem anatomy and (ii) on the xylem features along the maturity gradient. For the detailed anatomical characterization of root xylem, 14 days old seedlings which were grown in rhizotrons, have been carried out on the primary root. Root cross-sections were cut in positions sampled according to the principle of systematic uniform random sampling method. Along the root maturity, three sections per roots were made using cryotechnic procedure. Observations of the root and measurements of the vessels were carried out using the light microscope with Image Analyzing System. The obtained results of the comparative root xylem anatomy revealed significant phenotypic variability among tested genotypes. The ratio of cross-section xylem area, vessel diameter and theoretical hydraulic conductance ( $k_h$ ), increase along the maturity gradient for all genotypes. Significant differences in vessel size and frequency were recorded between wild species and cultivated genotypes. Wild annual species had smaller vessels diameter and consequently smaller cross-section vessel area and lower  $k_h$  compared to the cultivated genotypes. The largest number of vessels lumen for wild species had in range from 1500 to 3000  $\mu\text{m}^2$ . In cultivated genotypes the vessels with lumen area between 1700-2200  $\mu\text{m}^2$  as well as 4300-6000  $\mu\text{m}^2$  were the most numerous. The highest vessels percentage in relation to cross-section xylem area was recorded in the first and second sections for the most genotypes. The high variability of some xylem features, recorded in some genotypes, could be a result of their developmental plasticity. The results of this research will be useful in planning the future breeding strategies for the improvement of sunflower cultivars for drought tolerance.

**Keywords:** sunflower, root, anatomy, xylem

**Acknowledgment:** This work is supported by the Ministry of Education, Science and Technological Development of Republic of Serbia, grant number 451-03-68/2022-14/ 200032, by the Science Fund of the Republic of Serbia, through IDEAS project "Creating climate smart sunflower for future challenges" (SMARTSUN) grant number 7732457, by Center of Excellence for Innovations in Breeding of Climate-Resilient Crops - Climate Crops, Institute of Field and Vegetable Crops, Novi Sad, Serbia,, and the COST Action FA 1306: The quest for tolerant varieties -Phenotyping at plant and cellular level (STSM).

---

CIP - Каталогизација у публикацији  
Библиотеке Матице српске, Нови Сад

633.854.78(082)

INTERNATIONAL Sunflower Conference (20 ; 2022 ; Novi Sad)  
Proceedings of the 20th International Sunflower Conference, Novi Sad,  
June 20-23, 2022 / [editors Sreten Terzić, Dragana Miladinović]. - Novi Sad :  
The Institute of Field and Vegetable Crops ; Paris : The International Sunflower  
Association, 2022 (Novi Sad : Atelje «Mudri»). - 306 str. : ilustr. ; 25 cm

Tiraž 400. - Bibliografija uz svaki rad.

ISBN 978-86-80417-89-9

a) Сунцокрет - Узгајање - Зборници

COBISS.SR-ID 68512521

Front page design: Aleksandar Vojisavljević  
Photography: Goran Mulić – Petrovaradin fortress

---