

19TH INTERNATIONAL SUNFLOWER CONFERENCE



isc 2016

29 MAY – 3 JUNE, 2016

EDİRNE, TURKEY





ISC 2016



**PROCEEDINGS
OF
19TH INTERNATIONAL SUNFLOWER
CONFERENCE**

29 MAY – 3 JUNE, 2016

EDİRNE, TURKEY

**19TH INTERNATIONAL SUNFLOWER
CONFERENCE**

**29 MAY – 3 JUNE, 2016,
EDIRNE, TURKEY**

In

**Trakya University Balkan Congress Center,
Edirne, Turkey**

Organized by

Trakya University

and

International Sunflower Association

WELCOME from the CHAIR

You are welcome to our conference that will be jointly organized by Trakya University and International Sunflower Association. The aim of our conference is to present scientific subjects of a broad interest to the sunflower community, by providing an opportunity to present their work as oral or poster presentations that can be of great value for global sunflower production and trade. Our goal is to bring three communities, namely science, research, and private investment together in a friendly environment of Edirne, Turkey in order to share their interests and ideas and to benefit from the interaction with each other.

Our Conference held with record participation with over 600 people working on sunflower as researchers, scientists from seed companies, from oil industry and machinery coming from all part of the World. We have 300 papers which is a record number and almost doubles the previous meetings.

Due to many inquiries about combining our activities with oil industries in ISC 2016, International Sunflower Oil Quality Symposium are organized as one day as a side event during the conference. Sunflower farmers and growers will join also to our conference, so it will be also interesting as an initial attempt to bring together triangle dimensions as scientist, growers and industry in our conference.

Conference activities;

Plenary sessions with oral and poster presentations are on 30th, 31st of May and 1st of June 2016. Besides, the field day and the Sightseeing tours are on June 2nd – 3rd June 2016.

Agriculture is an important sector feeding all humankind, but it needs new developments and technologies to supply enough food for increasing world population year by year. Turkey is one of the most important contries on sunflower production and trade and an example to the leading agricultural economies in the world. Therefore, we hope that this conference will help to solve the problems encountered in the Sunflower community with establishing good network collaborations, joint projects and better relationships among countries with sharing our knowledge and experience together. We wish success to this meeting and hope a great scientific achievement together with your contributions.

Edirne is not only a very nice, lovely and historical city at the edge of Europe, but located just at the heart of Balkan region and history endowed with monuments reminding imperial past. We are much pleased to host you all in Edirne and in Turkey.

We would like to thank you to join this conference and we would like to give also special thanks our sponsors and collaborators for giving us big supports to organize this event.

We wish you nice stay in Edirne for truly rewarding days.

Assoc Prof Dr Yalcin KAYA

**Head of Organizing Committee
President of International Sunflower Association**

ORGANIZING COMMITTEE

LOCAL ORGANIZING COMMITTEE

Assoc. Prof. Dr. Yalçın KAYA	Trakya University	Head of Organizing Committee
Assist. Prof. Dr. Necmi BESER	Trakya University	Vice Chair of Organizing Commitee
Assoc. Prof. Dr. Semra HASANCEBI	Trakya University	Member
Asst. Prof. Dr. Suleyman KOK	Trakya University	Member
Asst. Prof. Dr. Gokhan KAÇAR	Trakya University	Member
Dr Mehmet YABAS	Trakya University	Member
Emrah AKPINAR	Trakya University	Member
Çağlar ÇOLAK	Trakya University	Member
Zeynep Çisem MUTAFÇILAR	Trakya University	Member
Gizem ÇİVİ	Trakya University	Member
Müge Türkoğlu KOÇ	Trakya University	Member
Bilge AFSAROGLU	Trakya University	Member
Serkan KOSEM	Edirne Com. Exchange	Member
Sukru TOPARLAK	Edirne Farmer Union	Member
Dilaver ARSLAN	TAGEM	Member
Dr. Goksel EVCI	Trakya Agric. Res Inst	Member
Dr. Veli PEKCAN	Trakya Agric. Res Inst	Member
M. Ibrahim YILMAZ	Trakya Agric. Res Inst	Member
Dr A. Semsettin TAN	Agean Agric. Res Inst	Member
Prof. Dr. Nazan DAGUSTU	Uludağ University	Member
Prof. Dr. Fadul ONEMLI	Namık Kemal University	Member
Asst. Prof. Dr. Orhan Onur ASKIN	Kirklareli University	Member
Dr Vehbi ESER	BISAB	Member
Kamil YILMAZ	TUBID	Member
Yıldıray GENCER	TURKTOB/TSUAB	Member
Dr Mete KÖMEAĞAÇ	TURKTED	Member
Dr. Maria PACUREANU	Fundulea Agric. Res Inst	Member
Assoc. Prof. Dr. Valentina ENCHEVA	Dobroudja Agric. Res Inst	Member
Dr. Vladimir MIKLIC	Novisad Agric. Res Inst.	Member
Dr. Mehmet DEMIRCI	Agrobest	Member
Mehmet GÜL	Euralis Seed	Member
Ömer IGID	May Seed	Member
Yücel KILIC	Limagrain Seed	Member
Aydın TUNCEL	Pioneer Seed	Member
Abdullah DİŞBUDAK	Soltis Seed	Member
İsmail M. ŞENTÜRK	Syngenta Seed	Member
Yunus YUMUŞAK	Biotek Seed	Member

INTERNATIONAL ORGANIZING COMMITTEE

NAME

COUNTRY

Dr. Felicity VEAR	France
Dr. Andre POUZET	France
Dr. Nikolai BOCHKARYOV	Russia
Dr. Branislav DOZET	Ukraine
Carlos FEOLI	Argentina
Dr Laszlo HARGITAY	Hungary
Dr. Maria JOITA-PACUREANU	Romania
Dr Stevan MASIREVIC	Serbia
Dr. Vladimir MIKLIC	Serbia
Alan SCOTT	Australia
Dr. Gerald SEILER	USA
Prof. Dr. Gian Paolo VANNOZZI	Italy
Dr. Leonardo VELASCO	Spain

SCIENTIFIC COMMITTEE

NAME	INSTITUTION	COUNTRY	AREA
Dr. Miguel A. CANTAMUTTO	INTA	ARGENTINA	Genetic Resources
Amelia B. B. DE ROMANO	Nidera S. A.	ARGENTINA	Disease Resistance
Dr. Abelardo J. DE LA VEGA	Pioneer Hi-Bred Co.	ARGENTINA	Physiology
Assoc. Prof. Dr. Roumiana VASSILEVSKA-IVANOVA	Inst. of Genetics, Sofia	BULGARIA	Genetic Resources
Dr. Loren RIESEBERG	University Vancouver	CANADA	Genomics
Dr. Nicolas LANGLADE	INRA, Toulouse	FRANCE	Genomics, Drought Resistance
Dr. Stephane MUNOS	INRA, Toulouse	FRANCE	Genomics
Dr. Philippe DEBAEKE	INRA, Toulouse	FRANCE	Agronomy
Dr. Emmanuelle MESTRIES	CETIOM, Toulouse	FRANCE	Disease Resistance
Thierry ANDRÉ	SOLTIS S. A.	FRANCE	Breeding
Sebastian CHATRE	Syngenta S. A.	FRANCE	Breeding
Dr. Sujatha Mulpuri	Direct. of Oilseeds Res.	INDIA	Molecular Breeding
Prof. Dr. Maria DUCA	Moldova Acad. of Sci	MOLDOVA	Orobanche Resistance
Prof. Dr. Gheorghe SIN	Academy for Agric. Sci.	ROMANIA	Agronomy
Dr. Yakov DEMURIN	VNIIMK Krasnodar	RUSSIA	Oil Quality
Dr. Tatyana ANTONOVA	VNIIMK Krasnodar	RUSSIA	Disease Resistance
Dr. Nada HLADNI	IFVC Novi-Sad	SERBIA	Confectionery
Dr. Goran MALIDZA	IFVC Novi-Sad	SERBIA	Herbicide Resistance, Weed Management
Dr. Dragana MILADINOVIC	IFVC Novi-Sad	SERBIA	Molecular Breeding
Dr. Siniša JOCIC	IFVC Novi-Sad	SERBIA	Breeding
Dr. Leire MOLINERO-RUIZ	CSIS Cordoba	SPAIN	Disease Resistance
Prof. Dr. Abdurrahim T. GOKSOY	Uludag University	TURKEY	Breeding
Prof. Dr. Dilek BASALMA	Ankara University	TURKEY	Agronomy
Prof. Dr. Hasan BAYDAR	Süleyman Demirel Univ	TURKEY	Oil Quality
Prof. Dr. Fatih KILLI	Sutcu Imam University	TURKEY	Confectionery
Dr. Nilgün SEZER AKMAN	TSUAB	TURKEY	Seed Certification
Dr. Sami SÜZER	Trakya Agric. Res. Inst	TURKEY	Agronomy
Dr. Walter ANYANGA	Serere Agric. Res. Inst.	UGANDA	Breeding
Dr. Brent HULKE	USDA-ARS Sunflower Research Unit	USA	Breeding
Dr. Lili QI	USDA-ARS Sunflower Research Unit	USA	Molecular Genetics
Dr. Janet KNODEL	North Dakota State Univ.	USA	Sunflower Insects
Dr. Laura MAREK	USDA-ARS Ames, Iowa	USA	Genetic Resources
Dr. Janet KNODEL	North Dakota State Univ.	USA	Sunflower Insects

INVITED SPEAKERS of ISC 2016

SESSIONS

Breeding
Molecular Breeding
Agronomy and Seed Production
Genetic Resources
Disease & Pest resistance and Management
Orobanche Resistance and Management
Abiotic Stress Tolerance and Management
Herbicide Resistance and Management
Confectionery

SPEAKER

Dr Branislav DOZET (Hungary)
Dr. Lili QI (USA)
Dr Philippe DEBAEKE (France)
Dr Laura MAREK (USA)
Prof Dr Steven MASIREVIC (Serbia)
Dr Maria JOITA-PACUREANU (Romania)
Dr Nicolas LANGLADE (France)
Dr Goran MALIDZA (Serbia)
Dr Nada HLADNI (Serbia)

INVITED SPEAKERS of INTERNATIONAL SUNFLOWER OIL QUALITY SYMPOSIUM

NAME	INSTITUTION	COUNTRY
Prof Dr Nurhan T. DUNFORD	Oklahoma State Univ.	USA
Fabrice THURON	Fat & Associates,	FRANCE
Dr Leanordo VELASCO	CSIC, Cordoba,	SPAIN

THE EDITORS OF PROCEEDING BOOK

Assoc Prof Dr Yalcin KAYA, Assoc Prof Dr Semra HASANCEBI

**SCIENTIFIC COMMITTEE of INTERNATIONAL SUNFLOWER OIL
QUALITY SYMPOSIUM**

Prof Dr Aziz TEKIN	YABITED, Turkey
Prof Dr Selma TURKAY	Istanbul Technical Univ., Turkey
Prof Dr Aytaç SAYGIN GÜMÜŞKESEN	Ege University, Turkey
Prof. Dr Beraat OZCELIK	Istanbul Technical Univ., Turkey
Prof Dr Enrique M. FORCE	CSIC, Sevilla, Spain
Prof Dr Nurhan T. DUNFORD	Oklahoma State University, USA
Assoc Prof Dr Umit GECGEL	Namik Kemal University, Turkey
Assoc Prof Dr Haci A. GULEC	Trakya University, Turkey
Asst Prof Dr Buket AŞKIN	Kırklareli University, Turkey
Dr Leanordo VELASCO	CSIC, Cordoba, Spain
Dr. Yakov DEMURIN	Vniimk Institute, Russia
Fabrice TURON	Fat & Associates, France
Huseyin BUYUKSAHIN	BYSD, Turkey
Metin YURDAGUL	MUMSAD, Turkey
Suat OZTURK	TYSD, Turkey



19TH INTERNATIONAL SUNFLOWER CONFERENCE
29 MAY – 3 JUNE, 2016
EDIRNE, TURKEY

CONFERENCE PROGRAM

GENERAL SESSION

SUNDAY, MAY 29th, 2016	
14 ⁰⁰ - 20 ³⁰	Registration at Hotels and Balkan Congress Center
MONDAY, MAY 30th, 2016	
08 ³⁰ - 09 ³⁰	Registration at Balkan Congress Center
09 ³⁰ - 10 ³⁰	Opening Ceremony Balkan Synphony Orchestra Slide Show: Sunflower from Soil to Table:Our Yellow Bride in the fields Giving Appreciation Certificates to our Sponsors
10 ³⁰ – 11 ⁰⁰	Coffee break
11 ⁰⁰ - 12 ³⁰	OPENING SESSION: Session Chair: PROF DR MARIA DUCA – Rector of University of Moldova Academy of Science
11 ⁰⁰ – 11 ⁴⁰	Invited Speaker Prof Dr. Dragan Skoric “HISTORY OF SUNFLOWER BREEDING IN THE WORLD”
11 ⁴⁰ – 12 ²⁰	Invited Speaker Dr. Lili Qi “MOLECULAR MAPPING OF THE DISEASE RESISTANCE GENES AND ITS IMPACT ON SUNFLOWER BREEDING”
12 ²⁰ – 12 ³⁰	DISCUSSION
12 ³⁰ – 13 ³⁰	LUNCH ((Courtesy of Nidera Semillas)

19th International Sunflower Conference, Edirne, Turkey, 2016

	GENETIC AND BREEDING	BIOTIC AND ABIOTIC STRESS TOLERANCE	CROP PRODUCTION AND MANAGEMENT	MOLECULAR GENETICS
	(Main Meeting Room)	(2 nd Floor Senate Meeting Room)	(2 nd Floor Left Meeting Room)	(2 nd Floor Right Meeting Room)
	30.05.2016 MONDAY	30.05.2016 MONDAY	30.05.2016 MONDAY	30.05.2016 MONDAY
13 ³⁰ -15 ³⁰	<i>1st Session Chair: CARLOS FEOLI</i>	<i>1st Session Chair: DR MARIA JOITA- PACUREANU</i>	<i>1st Session Chair: DR VALENTINA ENCHEVA</i>	<i>1st Session Chair: DR RENATE HORN</i>
13 ³⁰ -13 ⁵⁰	Invited Speaker DR BRANISLAV DOZET	The genetics and evolution of solar tracking – B. BLACKMAN, S. HARMER	Use of polymer hydrogel in soil moisture conservation for sunflower cultivation in rainfed situations of Northern Karnataka, India: A case study – U. SHANWAD, B. CHITTAPUR, SHANKERGOUD I, B. DESAI, GOVINDAPPA MR., V. KULKARNI	The cultivated sunflower pan genome provides insights on the wild sources of introgressions and their role in breeding – S. HUBNER, E. ZIGLER, J.R. MANDEL, D. SWANEVELDER, P. VINCOURT, N. LANGLADE, J. M. BURKE, L. H. RIESEBERG
13 ⁵⁰ -14 ¹⁰	Contemporary Challenges in Sunflower Breeding	Impact of exogenously applied glycine betaine on physiological attributes of sunflower under drought stress- NOSHIN I., NADIA Z., N. BATOOL, Q. BANO	Determination of the yield and yield components performance of some sunflowers (<i>Helianthus annuus</i> L.) under rainfed conditions – I. DEMIR	Principal Component Analysis for Carbon Isotope Discrimination-Related Traits in Recombinant Inbred Lines of Sunflower – A. L. ADIREDDY, T. LAMAZE, P. GRIEU
14 ¹⁰ -14 ³⁰	Genetic analysis of seed yield related traits under optimum and limited irrigation in sunflower – M. GHAFARI	Rapid invitro screening of sunflower genotypes for moisture stress tolerance using PEG 6000 - SHANKERGOUD I., SHESHIAH K. C.	Appropriate nitrogen (N) and phosphorus (P) fertilizer regime for sunflower (<i>Helianthus annuus</i> L.) in the humid tropics – E. AKPOJOTOR, V. OLOWE	Molecular Studies of Sunflower Responses to Abiotic Stresses – I. TINDAS, R. I. AYTEKIN, S. ÇALIŞKAN
14 ³⁰ -14 ⁵⁰	Breeding for sunflower hybrids adapted to climate change: the SUNRISE collaborative and multi-disciplinary Project - LUBRANO-LAVADERA A.S., M. COQUE, MUNOS S., DEBAEKE P., MANGIN B., GOUZY J., KEPHALIACOS C., PIQUEMAL J., PINOCHET X.,	Exploring drought tolerance related traits in <i>Helianthus argophyllus</i> , <i>Helianthus annuus</i> and their hybrids – M. MUBASHAR HUSSAIN, M. KAUSAR, M. KHAN, P. MONNEVEUX	Interactive Effects of Different Intra-Row spacing and Nitrogen Levels on Yield and Yield Components of confectionery sunflower (<i>Helianthus annuus</i> L.) genotype (Alaca) Under Ankara conditions – S. DAY, O. KOLSARICI	Comparative assessment of androgenic response in sunflower (<i>Helianthus annuus</i>) – N. AKGUL, E. ÇABUK ŞAHİN, Y. AYDIN, A. ALTINKUT UNCUOĞLU, G. EVCI, A GÜREL

19th International Sunflower Conference, Edirne, Turkey, 2016

	LANGLADE N.			
14 ⁵⁰ -15 ⁰⁰	Discussion	Discussion	Discussion	Discussion
15 ⁰⁰ -15 ³⁰	Coffee break	Coffee break	Coffee break	Coffee break
15 ³⁰ -17 ⁰⁰	2nd Session: Chair: DR VLADIMIR MIKLIC	2nd Session: Chair: DR FELICITY VEAR	2nd Session Chair: PROF DR GIAN PAOLO VANNOZZI	2nd Session Chair: DR PHILIPPE DEBAEKE
15 ³⁰ -15 ⁵⁰	Assessment of sunflower germplasm selected for cold tolerance under autumn planting conditions in Morocco - HOUMANAT K., MAZOUZ H., EL FECHTALI M., NABLOUSSI A.	Invited Speaker PROF DR STEVAN MAŠIREVIĆ	Global change adaptation: what future for sunflower crops and products? A foresight study for oilseed chains at 2030 horizon – E. PILORGE, A. M. TREMBLAY, F. MUEL	Molecular and genetic aspects of sunflower defensive response to downy mildew - T. ŞESTACOVA, A.PORT, M. DUCA
15 ⁵⁰ -16 ¹⁰	Perspective and challenges to develop high yielding, disease resistant and oil quality sunflower hybrids in India - R.K.SHEORAN		Sunflower diseases research progress and management	Bioactivity and Phytochemical Evaluation of Sunflower (<i>Helianthus annuus</i> L.) Leaf Extract – Y. BIBI, A. QAYYUM, S. NISA
16 ¹⁰ -16 ³⁰	Stability performance of new introduced sunflower hybrids for seed yield and its components under Sudan conditions – A. A. M. ABDALLA	Control of Verticillium dahliae causing sunflower wilt using Brassica green manures - DESSERRE D., MESTRIES E., DECHAMP-GUILLAUME G., SEASSAU C.	Effects of Different Organomineral and Inorganic Compound Fertilizers on Seed Yield and Some Yield Components of Sunflower (<i>H. annuus</i> L.) – S. SUZER, E. CULHACI	Molecular Studies involved in sunflower responses in drought stress - I. ALTINDAS, E. AKSOY, S. CALISKAN
16 ³⁰ 16 ⁴⁵	Discussion	Discussion	Discussion	Discussion
16 ⁴⁵ -18 ⁰⁰	Poster Session	Poster Session	Poster Session	Poster Session
19 ³⁰ -	Dinner Party (Courtesy of Syngenta)	Dinner Party (Courtesy of Syngenta)	Dinner Party (Courtesy of Syngenta)	Dinner Party (Courtesy of Syngenta)

	31.05.2016 TUESDAY	31.05.2016 TUESDAY	31.05.2016 TUESDAY	31.05.2016 TUESDAY
09 ³⁰ -10 ¹⁰	3RD Session Chair: DR OLIVIER COTTET	3RD Session Chair: PROF DR STEVAN MASIREVIC	3RD Session Chair: DR AMELIA BERTERO DE ROMANO	3RD Session Chair: DR DRAGANA MILADINOVIC
09 ³⁰ -09 ⁵⁰	Collection of wild <i>Helianthus anomalus</i> and <i>deserticola</i> sunflower from the desert southwest USA – G. SEILER, L. MAREK	Isolation and identification of pathogen of Sunflower <i>Fusarium Wilt</i> - JING G. YUAN YUAN Z., GUI Z., JIAN Z., KAI W., JUN Z.	Invited Speaker	Proteomic response of sunflower to drought stress – M. GHAFARI, M. TOORCHI, M. VALIZADEH
09 ⁵⁰ -10 ¹⁰	The b1 locus that controls apical shoot branching in <i>H. annuus</i> exhibits a molecular diversity linked to the breeding history of hybrids - DURIEZ P., BONIFACE, M. C., POUILLY N., VAUTRIN S., MAYJ., RODDE N., BERGES H., CARRERE S., GOUZY J., P. VINCOURT, J. PIQUEMAL, S. MUNOS	Distribution of <i>Plasmopara halstedii</i> pathotypes in Hungary – R. BÁN, A. KOVÁCS, G. BAGLYAS, M. PERCZEL, G. TUROCZI, K. KOROSI	DR PHILIPPE DEBAEKE	Identification of HaDELLA, HaGID1 as well as HaSLEEPY and HaSNEEZY genes involved in gibberellin signaling in sunflower - R. EWALD, N. GEHM, L. POPIOLKOWSKI, A. ANTELMANN, R. HORN
10 ¹⁰ -10 ³⁰	Phenotypic and genotypic characterization of 400 new sunflower pre-bred lines – G. BAUTE, W. ANYANGA, E. ALBRECHT, L. H. RIESEBERG	Exploitation of the knowledge on oomycete effectors to drive the discovery of durable disease resistance to downy mildew in sunflower – Y. PECRIX, L. BUENDIA, Q. GASCUEL, C. PENOUILH-SUZETTE, L. GODIARD	Chemical Broomrape (<i>Orobanche cumana</i>) control in Clearfield® sunflower with different Imazamox containing herbicide formulations – M. PFENNING, M. VALTIN, S. SASCHA, J. BESSAI	Characterization of sunflower inbred lines with high oleic acid content by DNA markers – B. B. BILGEN
10 ³⁰ -10 ⁵⁰	Developing well adapted hybrids in Europe by using a G*E approach - GAUTIER F., HELOISE H., MILAGROS G., SAUVAIRE D.	Response to sunflower (<i>Helianthus annuus</i> L.) plant at early growth stage to cadmium toxicity – Y. CIKILI, H. SAMET, N. C. ATIKMEN	Pulsar® Plus and Eurolightning® Plus - herbicides for enhanced weed control in Clearfield® Plus sunflower – J. BESSAI, SCHLÄFER S., PFENNING M., MORAN D., CARTIN J.	Evaluation of WRKY and MYB transcription factors in some downy mildew infected sunflower lines; microarray data analysis – E. FILIZ, I. I. ÖZYİĞİT, R. VATANSEVER

10 ⁵⁰ -11 ⁰⁰	Discussion	Discussion	Discussion	Discussion
11 ⁰⁰ -11 ²⁰	Coffee break	Coffee break	Coffee break	Coffee break
11 ²⁰ -12 ³⁰	4th Session Chair: DR SINISA JOCIC	4th Session Chair: DR MICHAEL FOLEY	4th Session Chair: DR SUJATHA MULPURI	4th Session Chair: PROF DR RISHI BEHL
11 ²⁰ -11 ⁴⁰	Correlation studies between SSR marker based genetic distance and heterosis in sunflower (<i>Helianthus annuus</i> L.) – V. KULKARNI, SHANKERGOUD I., SUPRIYA S.M, SURESHA P.G.	PCR combined with GFP tagged <i>Verticillium dahliae</i> confirmed the seeds transmission of Sunflower <i>Verticillium</i> Wilt - YUAN YUAN Z., GUI Z., JIAN Z., JUN Z.	Relationships between Germination and Vigor Tests with Field Emergence of Sunflower in Iran – H. SADEGHI, S. SHEIDAEI	Invited Speaker DR STEPHANE MUNOS De novo sequencing of the <i>Helianthus annuus</i> and <i>Orobanche cumana</i> genomes
11 ⁴⁰ -12 ⁰⁰	Optimization of Agrobacterium-mediated gene transfer systems in Turkish sunflower (<i>Helianthus annuus</i> L.) varieties – I. I. ÖZYİĞİT, S. KARADENİZ, H. TOMBULOĞLU, E. FILİZ	Stability of the level of partial resistance to white rot in sunflower – M. ANABELLA DINON, F. CASTAÑO, S. SAN MARTINO, J. LÚQUEZ, F. QUIROZ	Pest Monitoring and Handling System Based on 4G Mobile System – C. ATLIĞ	
12 ⁰⁰ -12 ²⁰	Inclusion of dominance effect in genomic selection model to improve predictive ability for sunflower hybrid performance – F. BONNAFOUS, N. LANGLADE, B. MANGIN	Genetic divergence among sunflower inbred lines and their convergent improvement for yield, quality and disease resistance- R. RANI - R. K. SHEORAN – S. CHANDER – R. K. BEHL	New seed treatment solutions for <i>Plasmospora</i> Resistance Management in Sunflower – F. BRANDL	Comparison of cytoplasmic male sterility based on PET1 and PET2 cytoplasm in sunflower (<i>Helianthus annuus</i> L.) - HORN R., REDDEMANN A., DRUMEVA M
12 ²⁰ -12 ³⁰	Discussion	Discussion	Discussion	Discussion
13 ³⁰ -13 ³⁰	Lunch (Courtesy of Edirne Farmer Union)	Lunch (Courtesy of Edirne Farmer Union)	Lunch (Courtesy of Edirne Farmer Union)	Lunch (Courtesy of Edirne Farmer Union)
13 ³⁰ -15 ³⁰	5th Session Chair: DR THIERRY ANDRE	5th Session Chair: DR ROBERT NEMETH	5th Session Chair: PROF DR BENJAMIN BLACKMAN	5th Session Chair: PROF DR DEJANA PANKOVIC
13 ³⁰ -13 ⁵⁰	Invited Speaker DR MARIA JOITA-PACUREANU Broomrape (<i>Orobanche cumana</i> Wallr.) - Update on racial	Cadmium-potassium interrelationships in sunflower (<i>Helianthus annuus</i> L.) – H. SAMET, Y. CIKILI, N. C. ATIKMEN	Performance of sunflower hybrids in black cotton soils of Northern Karnataka, India – U. SHANWAD, SHANKERGOUD I, S. N. SUDHAKARBABU, V. KULKARNI, GOVINDAPPA MR, VIJAYKUMAR G.	Approaches for improvement of resistance to powdery mildew in sunflower (<i>Helianthus annuus</i> L.) – S. MULPURI, K. PALCHAMY, C. R. SANKARANENI, V. KODEBOYİNA

13 ⁵⁰ -14 ₁₀	composition and distribution, host resistance and management	Effects of Micro Nutrients (Fe, Zn, B and Mn) on Yield and Yield Components of Two Sunflower (<i>Helianthus annuus</i> L.) Cultivars in Urmia Condition – A. RAHIMI, J. JALILIAN	Modeling sunflower fungal complex to help design integrated pest management strategies - AUBERTOT J. N., MESTRIES E., M. A. VEDY-ZECCHINI, P. DEBAEKE	Genetic engineering studies on sunflower- M. E. ÇALIŞKAN, S. DAS DANGOL
14 ¹⁰ -14 ₃₀	Testing annual wild sunflower species for resistance to <i>Orobanche cumana</i> Wallr – S. TERZIĆ, B. DEDIĆ, J. ATLAGIĆ, S. JOCIĆ, D. MILADINOVIĆ, M. JOCKOVIĆ	Quantification of drought tolerance levels of sunflower inbred lines by means of <i>chlorophyll</i> -a fluorescence - A. S. BALKAN, NALCAIYI, S. CULHA ERDAL - O. GUNDUZ, V. PEKCAN, O. ARSLAN, N. CICEK, Y. KAYA, Y. EKMEKCI	Escape to tiny bug (<i>Nysius simulans</i> Stål) attack across planting date adjustment in sunflower hybrid seed crops from southern BuenosAires province, Argentine – J. RENZI, O. REINOSO, M. BRUNA, M. AVALOS, M. CANTAMUTTO	Invited Speaker DR NICOLAS LANGLADE Genome-wide association of oil yield plasticity to drought, nitrogen and chilling stresses in sunflower
14 ³⁰ -14 ₅₀	Determination of superior hybrid combinations in sunflower and testing of their resistance to broomrape (<i>Orobanche cumana</i> Wallr.) In infested areas – O. GÜNDÜZ, A. T. GOKSOY	The effect of climate factors and climate change on the yield of sunflower (<i>Helianthus annuus</i> L.) in Marmara region – H. GURKAN, H. BULUT, N. BAYRAKTAR, M. DEMIRCAN, O. ESKİOĞLU, N. KOÇAK	Current Situation, Problems and Solutions of Sunflower in the Central Anatolian Region – C. YAVUZ, S. CALISKAN	
14 ⁵⁰ -15 ₀₀	Discussion	Discussion	Discussion	Discussion
15 ⁰⁰ -15 ₃₀	Coffee break	Coffee break	Coffee break	Coffee break
15 ³⁰ -17 ₀₀	6th Session Chair: DR CHAO CHIEN JAN	6th Session: Chair: DR GERALD SEILER	6th Session Chair: PROF DR MICHELLE GILLEY	6th Session Chair: DR STEPHANE MUNOS
15 ³⁰ -15 ₅₀	Invited Speaker DR GORAN MALIDZA	Effects of Naphthalene Acetic Acid and N6-Benzyladenine on Androgenesis in <i>Helianthus annuus</i> L. Anthers - S. DAYAN, H. ARDA	Microbial Dressing of Sunflower Seeds with <i>Trichoderma harzianum</i> KUEN 1585 – Y. S. YONSEL, M. SEVİM	QTL mapping for broomrape (<i>Orobanche cumana</i> Wallr.) resistance in sunflower – I. CELİK, D. ZARARSIZ, A. FRARY, S. DOGANLAR
15 ⁵⁰ -16 ₁₀	Integrated weed management in sunflower: Challenges and opportunities	Do cell wall proteins affect the setting of grains and their potential weight in sunflower? – D. CALDERINI, S. VASQUEZ, F. CASTILLO, P.	Green and brown bridges aid survival of multiple <i>Diaporthe</i> / <i>Phomopsis</i> species with a range of virulences on sunflower, soybeans,	Determination the genetic characterization of different lines of sunflower (<i>Helianthus annuus</i> L.) by using genetic resources

19th International Sunflower Conference, Edirne, Turkey, 2016

		MONTECINOS, A. CLAUDE, C. LIZANA, R. RIEGEL	mungbeans and other crops in Australia. – S. THOMPSON, S. NEATE, Y. PEI TAN, R. SHIVAS, E. AITKEN	based on SSRs (Simple Sequence Repeat) – D. BASALMA, M. PASHAZADEH
16 ¹⁰ -16 ³⁰	Advancements in Clearfield® Plus Sunflower Hybrid Variety Development – B. WESTON, M. PFENNING, C. NIETO, P. ANGELETTI, E. SAKIMA	The Estimating Drought Stress Tolerances of Sunflower Inbred lines under controlled environmental conditions – O. ARSLAN, A. S. BALKAN NALCAIYI, G. EVCI, V. PEKCAN, I. M. YILMAZ, S. ÇULHA ERDAL, N. CICEK, Y. KAYA, Y. EKMEKCI	Evaluation of Sunflower (<i>Helianthus annuus</i> L.) Hybrids for Photothermal Units Accumulation, Oil Yield, Oil Quality and Yield Traits under Spring Planting Conditions of Haripur, Pakistan – A. QAYYUM, I. SULTAN, S. U. KHAN, Y. BIBI, A. MEHMOOD, A. SHER, M. A. JENKS	Study of the genomic diversity of <i>Verticillium sp.</i> capable of colonizing sunflower. How knowledge of pathogen genetic structure can be combined with classical breeding approaches to guide it – H. MISSONNIER, F. LUIGI, L. GWENAELE, DAYDÉ J, J. ALBAN, THOMMA B. PHJ
16 ³⁰ -16 ⁴⁵	Discussion	Discussion	Discussion	Discussion
16 ⁴⁵ -18 ⁰⁰	Poster Session	Poster Session	Poster Session	Poster Session
19 ³⁰ -	Dinner Party	Dinner Party	Dinner Party	Dinner Party
	01. 06.2016 WEDNESDAY	01. 06.2016 WEDNESDAY	01. 06.2016 WEDNESDAY	01. 06.2016 WEDNESDAY
09 ³⁰ -11 ⁰⁰	7th Session Chair: DR MIGUEL CANTAMUTTO	REGISTRATION		
09 ³⁰ -09 ⁵⁰	The effects of applied herbicides on yield and oil quality components of two oleic and two linoleic sunflower (<i>Helianthus annuus</i> L.) hybrids – F. ONEMLI, U. TETIK	INTERNATIONAL SUNFLOWER OIL QUALITY SYMPOSIUM Opening Ceremony		
09 ⁵⁰ -10 ¹⁰	New virulences of <i>Orobanche cumana</i> appear in Romania - PARVU N., TEODORESCU A.	Session Chair: PROF DR MEHMET EMIN CALISKAN Invited Speaker Fabrice THURON - "HO Oilseeds and Oils Market: Positioning Sunflower Today and Tomorrow		
10 ¹⁰ -10 ³⁰	Genetic characterization of the interaction between sunflower and <i>Orobanche cumana</i> - LOUARN J., M. C. BONIFACE, POUILLY N., VELASCO L., P. VINCOURT, B.	Invited Speaker Prof Dr Nurhan TURGUT DUNFORD Sunflower Oil: A Premium Oil for Food Applications		

	PÉREZ-VICH, MUNOS S.		
10 ³⁰ -10 ⁵⁰	Study of <i>Orobanche cumana</i> genetic diversity – M. COQUE, T. ANDRE, R. GIMENEZ, M. ARCHIPIANO, L. POLOVYNKO, M. C. TARDIN, C. JESTIN, B. GREZES-BESSET	Invited Speaker DR. LEONARDO VELASCO Source and sink affect phytosterol concentration and composition of sunflower oil	
10 ⁵⁰ -11 ⁰⁰	Discussion	Discussion	Discussion
11 ⁰⁰ -11 ²⁰	Coffee break	Coffee break	Coffee break
11 ²⁰ -12 ³⁰	8th Session: Chair: DR LOREN H. RIESEBERG	8th Session: Chair: DR LEONARDO VELASCO	8th Session: Chair: PROF DR ZHAO JUN
11 ²⁰ -11 ⁴⁰	Invited Speaker DR LAURA F. MAREK	Oil content and oil quality characteristics of linoleic and high-oleic sunflower varieties cultivated in Turkey – B. ASKIN, M. AFACAN, V. BİCER, Ö. KARADAS, İ. KONUK	Quality characteristics of roasted sunflower seeds during storage - M. B. BAHAR, F. SEYHAN, B. OZTURK, B. TOPAL, F. S. BAYRAKTAR
11 ⁴⁰ -12 ⁰⁰	Sunflower Genetic Resources	Determination of Textural, Rheological Properties and SFC, SMP Values of Oleogels Prepared Using Sunflower Oil – H. PEHLİVANOĞLU, O. S. TOKER, H. IMAMOĞLU, M DEMIRCI	Effect of different storage conditions on quality properties of raw and roasted sunflower kernels – F. SEYHAN, M. B. BAHAR, B. TOPAL, B. ÖZTÜRK, F. S. BAYRAKTAR
12 ⁰⁰ -12 ²⁰	Four decades of sunflower genetic resources activities in India – M. DUDHE, S. MULPURI	Assessment of sunflower oil adulteration – A. CEVIK, A. UNVER	The Evaluation of Sunflower Harvest Waste as Silage Feed – S. BUYUKKILIC BEYZI, M. YILMAZ, Y. KONCA
12 ²⁰ -12 ³⁰	Discussion	Discussion	Discussion
12 ³⁰ -13 ³⁰	Lunch (Courtesy of Edirne Commodity Exchange)		
13 ³⁰ -15 ³⁰	9th Session Chair: DR ABELARDO DE LA VEGA	9th Session Chair: PROF DR NURHAN T. DUNFORD	9th Session Chair: PROF DR SEVGI CALISKAN
13 ³⁰ -13 ⁵⁰	Invited Speaker DR NADA HLADNI	The effects of vacuum and atmospheric deep-fat frying process on total frying-use time of sunflower oil and on french fries quality – E. DEVSEREN, D. TOMRUK, U. BAYSAN, M. KOC, H. KARATAŞ, F. ERTEKIN	Study of the characteristics of cultivated varieties of sunflower, regarding the production of high quality sunflower meal with dehulling process - S. DAUGUET, F. LABALETTE, F. FINE, P. CARRE, A.MERRIEN, J. P. PALLEAU
13 ⁵⁰ -14 ¹⁰	Present status and future prospects of global confectionery sunflower production	Effect of curcumin nanoparticles on oxidative stability of sunflower oil-in-water emulsions – F. BOZKURT, M. T. YILMAZ, C. YILDIRIM	Acceptability of chapati Made With Supplementation of Sunflower (<i>Helianthus annuus</i> L.) Seed Meal – M. KARWASRA, S. DHIYA

19th International Sunflower Conference, Edirne, Turkey, 2016

14 ¹⁰ -14 ³⁰	Grain, kernel and hull characterization of oilseed and oilseed x confectionary genotypes- S. ZUIL, M. LAUREANO, P. ROCCA, M. DELLA MADDALENA	Application of artificial neural network on prediction of moisture content of the deep-fat frying of beef meatballs in sunflower oil-H.I. KOZAN, C. SARIÇOBAN, H. AKYÜREK	Some Antinutrients and in vitro Protein Digestibility of Home Processed Sunflower Seed Meal – M. KARWASRA, S. DHIYA
14 ³⁰ -14 ⁵⁰	Effects of herbicide and salinity stresses on some defense responses of sunflower plant- A. KAYA	Effect of the Deep-Fat Frying Process on Aroma Compounds of Sunflower Seed Oil – S. KESEN, A. S. SÖNMEZDAĞ, A. AMANPOUR, H. KELEBEK, S. SELLI	
14 ⁵⁰ -5 ⁰⁰	Discussion	Discussion	Discussion
15 ⁰⁰ -15 ³⁰	Coffee break	Coffee break	Coffee break
15 ³⁰ -17 ⁰⁰	10th Session Chair: DR PIERRE CASADEBEIG	10th Session Chair: DR SUSAN THOMPSON	10th Session Chair: DR NICOLAS LANGLADE
15 ³⁰ -15 ⁵⁰	Quantitative Determination of Sunflower in Mixed Concentrate Feeds by Real Time PCR- M. KAYA,Z. KIYMA	The Effect of the ESSENTIAL OIL from <i>Citrus aurantium</i> as a source of natural antioxidant in sunflower oil – O. ERDOĞDU, A. BOZDOGAN	The Meeting of International Consortium for Sunflower Genomic Resources
15 ⁵⁰ -16 ¹⁰	The evaluation of annual wild <i>Helianthus</i> species for their morphological, phenological and seed chemical characteristics in field conditions – F. ONEMLI, G. ONEMLI	LC-DAD/ESI-MS/MS Characterization of Phenolic Compounds of Sunflower oil – H. KELEBEK, S. SELLI, A. S. SÖNMEZDAĞ, S. KESEN, G. GUCLU, O. KOLA	
16 ¹⁰ -16 ³⁰		Lessons from ten years of an interprofessional survey plan on sunflower food safety - S. DAUGUET, F. LACOSTE	
16 ³⁰ -16 ⁴⁵	Discussion	Discussion	

19th International Sunflower Conference, Edirne, Turkey, 2016

16 ⁴⁵ -17 ⁴⁵	ISA GENERAL ASSEMBLY
17 ⁴⁵ -18 ⁰⁰	<i>Closing Ceremony</i>
19 ³⁰ -23 ³⁰	GALA DINNER

	02.06.2016 THURSDAY
09 ³⁰ -12 ⁰⁰	Field Day in Trakya Agricultural Research Institute Visiting Demo Plots
12 ⁰⁰ -13 ⁰⁰	Lunch
13 ³⁰ -17 ³⁰	Edirne City Tour
17 ³⁰ -	Free Shopping Time

	03.06.2016 FRIDAY
07 ⁰⁰ -19 ³⁰	Istanbul City Tour
19 ³⁰ -23 ³⁰	Bosphorus Yacht Tour and Dinner

CONTENTS

ORGANIZING COMMITTEE	1
SCIENTIFIC COMMITTEE	3
INVITED SPEAKERS OF ISC 2016	4
SCIENTIFIC COMMITTEE OF INTERNATIONAL SUNFLOWER OIL QUALITY SYMPOSIUM	5
CONFERENCE PROGRAM	6
CONTENTS	1
KEYNOTE PAPERS	9
HISTORY OF SUNFLOWER BREEDING IN THE WORLD	10
CONTEMPORARY CHALLENGES IN SUNFLOWER BREEDING	11
MOLECULAR MAPPING OF THE DISEASE RESISTANCE GENE AND ITS IMPACT ON SUNFLOWER BREEDING	20
SUNFLOWER GENETIC RESOURCES	31
PRESENT STATUS AND FUTURE PROSPECTS OF GLOBAL CONFECTIONERY SUNFLOWER PRODUCTION	45
SUNFLOWER DISEASES RESEARCH PROGRESS AND MANAGEMENT	60
BROOMRAPE (<i>OROBANCHE CUMANA</i> WALLR.) IN SUNFLOWER – UPDATE ON RACIAL COMPOSITION AND DISTRIBUTION, HOST RESISTANCE AND MANAGEMENT	70
INTEGRATED WEED MANAGEMENT IN SUNFLOWER: CHALLENGES AND OPPORTUNITIES	90
SUNFLOWER CROP AND CLIMATE CHANGE IN EUROPE: VULNERABILITY, ADAPTATION, AND MITIGATION POTENTIAL.....	100
SUNFLOWER SEED OIL: A PREMIUM OIL FOR FOOD APPLICATIONS	117
SOURCE AND SINK AFFECT PHYTOSTEROL CONCENTRATION AND COMPOSITION OF SUNFLOWER OIL	118
PHYSIOLOGY	126
DO CELL WALL PROTEINS AFFECT THE SETTING OF GRAINS AND THEIR POTENTIAL WEIGHT IN SUNFLOWER?	127
THE GENETICS AND EVOLUTION OF SOLAR TRACKING	128
EVALUATION OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) SINGLE CROSS HYBRIDS UNDER HEAT STRESS CONDITION.....	138
EXPLORING DROUGHT TOLERANCE RELATED TRAITS IN (<i>HELIANTHUS ARGOPHYLLUS</i> , <i>HELIANTHUS ANNUUS</i>) AND THEIR HYBRIDS	148
EFFECTS OF HERBICIDE AND SALINITY STRESSES ON SOME DEFENSE RESPONSES OF SUNFLOWER PLANT	157
IMPACT OF EXOGENOUSLY APPLIED GLYCINE BETAINE ON PHYSIOLOGICAL ATTRIBUTES OF SUNFLOWER UNDER DROUGHT STRESS	158
BIOACTIVITY AND PHYTOCHEMICAL EVALUATION OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) LEAF EXTRACT	175
THE ESTIMATING DROUGHT STRESS TOLERANCES OF SUNFLOWER INBRED LINES UNDER CONTROLLED	176
EFFECTS OF NAPHTHALENEACETIC ACID AND N6-BENZYLADENINE ON ANDROGENESIS IN <i>HELIANTHUS ANNUUS</i> L.	177
CYTOKININS: THE KEY TO DIFFERENCES IN PATTERNS OF CANOPY SENESCENCE IN STAY-GREEN AND FAST DRY-DOWN SUNFLOWER HYBRIDS	185
PHYSIOLOGICAL BASIS AND ANTIOXIDANT ACTIVITY IN COLD STRESS RECOVER IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	186
EXPRESSION OF DEFENSE RELATED GENES IN LEAVES OF TWO SUNFLOWER LINES AFTER INFECTION WITH SPORES OF <i>PLASMOPARA HALSTEDII</i>	187
A SOURCE-SINK BASED DYNAMIC MODEL FOR SIMULATING OIL AND PROTEIN ACCUMULATION IN SUNFLOWER ACHENES	188
MORPHOANATOMY OF INCOMPLETELY DEVELOPED FRUITS IN THE SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	189
LIGHT DEPENDANT BIOSYNTHESIS OF SESQUITERPENE LACTONES IN SUNFLOWER	190
LEAF SENESCENCE IN SUNFLOWER WAS ADVANCED OR DELAYED DEPENDING ON CHANGES IN THE SOURCE-SINK RATIO DURING THE GRAIN FILLING PERIOD	191
TWO SIMPLE MODELS INCLUDING THE SOURCE/SINK RATIO TO EXPLAIN BLACK STEM BY <i>PHOMA MACDONALDII</i> IN SUNFLOWER.....	201
CALLUS FORMATION AND PLANT REGENERATION IN SUNFLOWER (<i>HELIANTHUS</i> L., <i>ASTERACEAE</i>) IN VITRO TISSUE CULTURE	211

OBSERVATIONS ON IMI GROUP HERBICIDES STRESS ON SUNFLOWER LEAVES (<i>HELIANTHUS ANNUUS</i> L.) BY SCANNING ELECTRON MICROSCOPY.....	218
A STUDY ON THE STANDARD GERMINATION AND SEEDLING GROWTH OF SOME CONFECTIONARY AND OIL SEED SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) CULTIVARS.....	219
DETERMINATION OF ACCELERATED AGING AND FIELD GERMINATION TEST VALUES OF SOME CONFECTIONARY AND OILSEED SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) CULTIVARS.....	224
GENETICS AND BREEDING	230
GENETIC ANALYSIS OF SEED YIELD RELATED TRAITS UNDER OPTIMUM AND LIMITED IRRIGATION IN SUNFLOWER.....	231
A UNIQUE CYTOPLASMIC-NUCLEAR INTERACTION CAUSING SUNFLOWER PLANTS WITH REDUCED VIGOR AND THE GENETICS OF VIGOR RESTORATION.....	238
CORRELATION STUDIES OF SSR MARKER BASED GENETIC DISTANCE AND HETEROSIS IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.).....	239
STABILITY OF THE LEVEL OF PARTIAL RESISTANCE TO WHITE ROT IN SUNFLOWER.....	245
COLLECTION OF WILD <i>HELIANTHUS ANOMALUS</i> AND <i>DESERTICOLA</i> SUNFLOWER FROM THE DESERT SOUTHWEST USA.....	253
PHENOTYPIC AND GENOTYPIC CHARACTERIZATION OF 400 NEW SUNFLOWER PRE-BRED LINES.....	263
THE EVALUATION OF ANNUAL WILD <i>HELIANTHUS</i> SPECIES FOR THEIR MORPHOLOGICAL, PHENOLOGICAL AND SEED CHEMICAL CHARACTERISTICS IN FIELD CONDITIONS.....	264
PRINCIPAL COMPONENT ANALYSIS FOR CARBON ISOTOPE DISCRIMINATION-RELATED TRAITS IN RECOMBINANT INBRED LINES OF SUNFLOWER.....	276
NEW VIRULENCES OF <i>OROBANCHE CUMANA</i> APPEAR IN ROMANIA.....	277
THE CULTIVATED SUNFLOWER PAN GENOME PROVIDES INSIGHTS ON THE WILD SOURCES OF INTROGRESSIONS AND THEIR ROLE IN BREEDING.....	278
STABILITY PERFORMANCE OF NEW INTRODUCED SUNFLOWER HYBRIDS FOR SEED YIELD AND ITS COMPONENTS UNDER SUDAN CONDITIONS.....	279
ADVANCEMENTS IN CLEARFIELD® PLUS SUNFLOWER HYBRID VARIETY DEVELOPMENT.....	286
GRAIN, KERNEL AND HULL CHARACTERIZATION OF OILSEED AND OILSEED X CONFECTIONARY GENOTYPES.....	287
DEVELOPING WELL ADAPTED HYBRIDS IN EUROPE BY USING A G*E APPROACH.....	296
OPTIMIZATION OF AGROBACTERIUM-MEDIATED GENE TRANSFER SYSTEMS IN TURKISH SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) VARIETIES.....	297
INCLUSION OF DOMINANCE EFFECT IN GENOMIC SELECTION MODEL TO IMPROVE PREDICTIVE ABILITY FOR SUNFLOWER HYBRID PERFORMANCE.....	298
ASSESSMENT OF SUNFLOWER GERMPLASM SELECTED UNDER AUTUMN PLANTING CONDITIONS.....	299
TESTING ANNUAL WILD SUNFLOWER SPECIES FOR RESISTANCE TO <i>OROBANCHE CUMANA</i> WALLR.....	307
STUDY OF THE CHARACTERISTICS OF CULTIVATED VARIETIES OF SUNFLOWER, REGARDING THE PRODUCTION OF HIGH QUALITY SUNFLOWER MEAL WITH DEHULLING PROCESS.....	308
THE B1 LOCUS THAT CONTROLS APICAL SHOOT BRANCHING IN <i>HELIANTHUS ANNUUS</i> EXHIBITS A MOLECULAR DIVERSITY LINKED TO THE BREEDING HISTORY OF HYBRIDS.....	325
EFFECTS OF OSMOTIC STRESS WITH DIFFERENT HORMON COMBINATIONS ON CALLUS INDUCTION IN SUNFLOWER ANTHERS.....	326
CONFECTIONERY SUNFLOWER HYBRID BREEDING IN VNIIMK (RUSSIA).....	327
POPULATION STRUCTURE, LINKAGE DISEQUILIBRIUM AND ASSOCIATION MAPPING FOR MORPHOLOGICAL TRAITS IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.).....	331
MAPPING QTL CONTROLLING SALT TOLERANCE INDICES IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.).....	332
GENETIC DIVERSITY OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) LINES UNDER NORMAL AND SALT STRESS CONDITIONS USING MULTIVARIATE STATISTICAL ANALYSIS.....	333
FOUR DECADES OF SUNFLOWER GENETIC RESOURCES ACTIVITIES IN INDIA.....	334
QTL MAPPING FOR BROOMRAPE (<i>OROBANCHE CUMANA</i> WALLR.) RESISTANCE IN SUNFLOWER.....	335
PERSPECTIVE AND CHALLENGES TO DEVELOP HIGH YIELDING, DISEASE RESISTANT AND OIL QUALITY SUNFLOWER HYBRIDS IN INDIA.....	336
MOLECULAR AND GENETIC ASPECTS OF SUNFLOWER DEFENSIVE RESPONSE TO DOWNY MILDEW.....	343
COMPARATIVE ASSESSMENT OF ANDROGENIC RESPONSE IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i>).....	344
APPLYING THE TOOLS OF GENOMICS TO SUNFLOWER BREEDING ISSUES.....	345
DETERMINATION OF SUPERIOR HYBRID COMBINATIONS IN SUNFLOWER AND TESTING OF THEIR RESISTANCE TO BROOMRAPE (<i>OROBANCHE CUMANA</i> WALLR.) IN INFESTED AREAS.....	346

RECENT MOLECULAR STUDIES ON DOWNY MILDEW DISEASE.....	363
MOLECULAR STUDIES OF SUNFLOWER RESPONSES TO ABIOTIC STRESSES	371
MOLECULAR STUDIES INVOLVED IN SUNFLOWER RESPONSES IN DROUGHT STRESS.....	381
DETERMINATION THE GENETIC CHARACTERIZATION OF DIFFERENT LINES OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) BY USING GENETIC RESOURCES BASED ON SSRs (SIMPLE SEQUENCE REPEAT)	389
GENETIC DIVERGENCE IN SUNFLOWER ACCESSIONS	397
COMBINING ABILITY AND GENETIC COMPONENTS FOR SEED YIELD IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	402
RECOMBINATION AND SELECTION IN SUNFLOWER POPULATIONS FROM EEA PERGAMINO INTA	407
AN EMS MUTATION ALTERING OIL QUALITY IN SUNFLOWER INBRED LINE.....	414
SUNFLOWER GENETIC GAIN IN ARGENTINA.....	422
PRODUCTION POTENTIAL OF NEW SUNFLOWER HYBRIDS DEVELOPED AT DOBRUDZHA AGRICULTURAL INSTITUTE – GENERAL TOSHEVO	431
HYBRIDIZATION BETWEEN CULTIVATED SUNFLOWER AND WILD ANNUAL SPECIES <i>HELIANTHUS NEGLECTUS</i> HEISER	443
COMPARATIVE INVESTIGATION OF IMMATURE EMBRYOS GROWING OF INTERSPECIFIC SUNFLOWER HYBRIDS	449
DEVELOPMENT OF SUNFLOWER HYBRIDS RESISTANT TO HERBISIDES	454
RESPONSE TO WATER STRESS INDUCED BY PEG 6000 ON GROWTH OF PLANTLETS IN SOME SUNFLOWER GENOTYPES RESULTED FROM INTERSPECIFIC HYBRIDISATION	462
A NEW BULGARIAN SUNFLOWER HYBRID DEA	463
INVESTIGATION ON SUNFLOWER LINES AND HYBRIDS (<i>HELIANTHUS ANNUUS</i> L.) FOR EXPRESSION OF HETEROSIS AND DOMINANCE RATE OF IMPORTANT ECONOMIC TRAITS IN F ₁ UNDER THE CONDITIONS OF NORTH-EAST BULGARIA	472
MORPHOLOGICAL CHARACTERIZATION OF UGA-SAM1 SUNFLOWER ASSOCIATION MAPPING POPULATION.....	479
HIGH OLEIC SUNFLOWER HYBRID OXY WITH CHANGED SEED TOCOPHEROL CONTENT	480
VALIDATION OF SCAR-MARKER FOR RESTORATION FERTILITY GENE IN UKRAINIAN INITIAL MATERIAL OF SUNFLOWER	484
THE PUBLIC SUNFLOWER ASSOCIATION MAPPING POPULATION	489
FH-586- A SHORT DURATION HIGH YIELDING SUNFLOWER HYBRID UNDER SEMIARID CONDITIONS.....	490
BROADENING THE GENETIC BASE OF CULTIVATED SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) IN INDIA THROUGH PREBREEDING	491
MOLECULAR BREEDING FOR MAJOR DISEASES OF SUNFLOWER IN INDIA: PRESENT STATUS AND FUTURE NEEDS.....	492
GENE EFFECTS AND COMBINING ABILITIES OF SUNFLOWER YIELD AND MORPHOLOGICAL TRAITS BY LINE X TESTER MATING DESIGN	493
SOURCE-SINK RATIO EFFECTS ON THE EXPRESSION OF GENES ASSOCIATED WITH GRAIN GROWTH IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	499
PRODUCTIVITY AND QUALITY TRAITS OF SUNFLOWER INBRED LINE COLLECTION OF KAZAKHSTAN	508
THE EFFECT OF SOWING DATE AND DENSITY ON CALLUS INDUCTION AND SHOOT REGENERATION FROM SUNFLOWER ANTHERS	509
DEVELOPMENT OF SUNFLOWER NECROSIS VIRUS (SNV) DISEASE IN SOUTH INDIA.....	515
GENOME WIDE ASSOCIATION STUDIES ON SUNRISE GWA POPULATION.....	518
SCREENING FOR RESISTANCE TO HIGHLY VIRULENT RACES OF SUNFLOWER BROOMRAPE (<i>OROBANCHE CUMANA</i>)	519
PREVALENCE OF SUNFLOWER DOWNY MILDEW AND PATHOGEN VIRULENCE IN THE UNITED STATES NORTH CENTRAL GREAT PLAINS	520
OILSEED AND CONFECTIONARY (SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) RESEARCHES IN AEGEAN AGRICULTURAL RESEARCH INSTITUTE (AARI).....	527
PERFORMANCE OF SOME OILSEED SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) VARIETIES IN AEGEAN REGION OF TURKEY	535
PERFORMANCE OF SOME CONFECTIONARY SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) VARIETIES IN AEGEAN REGION OF TURKEY	548
OILSEED AND CONFECTIONARY SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) LANDRACES OF TURKEY	556
THE FRENCH BIOLOGICAL RESOURCES CENTER DEDICATED TO <i>HELIANTHUS</i> : CRB.TOURNESOL@TOULOUSE.INRA.FR	567
EVALUATION OF VARIATION ON SUNFLOWER SINGLE CROSSES	568
HYBRIDIZATION BETWEEN SUNFLOWERS (<i>HELIANTHUS ANNUUS</i> L.) AND LESS STEM ROSETTE (<i>CARLINA ACANTHIFOLIA</i> ALL.). CHARACTERIZATION OF RECEIVED INTERGENERIC FORMS	578
SUNFLOWER VERTICILLIUM WILT: BEHAVIOUR OF COMMERCIAL HYBRIDS IN QUICK TESTS PERFORMED AT CONTROLLED CONDITIONS.	583
ARGENTINEAN AND EUROPEAN SUNFLOWER HYBRID PERFORMANCE IN A <i>VERTICILLIUM</i> INFECTARIUM	584
CHARACTERIZATION OF <i>HELIANTHUS TUBEROSUS</i> L. ACCESSIONS FROM VIR COLLECTION.....	585
GENETIC RESOURCES FOR THE BREEDING OF LARGE FRUIT SUNFLOWER	586

CAN GENOTYPE X ENVIRONMENT MANAGEMENT INTERACTIONS (GEMI) BE PREDICTED IN SUNFLOWER MULTI-ENVIRONMENT TRIAL?.....	587
SUNRISE PHENOTYPING DATABASE: A TOOL FOR THE SUNFLOWER COMMUNITY TO SHARE AGRONOMIC, PHYSIOLOGICAL AND MOLECULAR DATA	588
NEW TECHNICAL AND METHODOLOGICAL DEVELOPMENTS FOR SUNFLOWER FIELD PHENOTYPING.....	589
DIVERSIFICATION OF SUNFLOWER GERMPLASM FOR DIFFERENT IMPORTANT CHARACTERISTICS	590
CURRENT STATUS OF SUNFLOWER CROP MANAGEMENT IN MOLDOVA.....	591
EFFECT OF GIBBERELIC ACID ON POLLEN DEVELOPMENT IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	592
GENETIC VARIABILITY OF BROOMRAPE POPULATIONS FROM REPUBLIC OF MOLDOVA	593
MICROSPORE CULTURE RESPONSE OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) CULTIVARS.....	594
GENOTOXIC EFFECTS OF IN VITRO TISSUE CULTURE CONDITIONS IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)....	595
NEW RACE OF BROOMRAPE IN SOUTH REGION OF UKRAINE.....	596
TISSUE CULTURE STUDIES IN SUNFLOWER	597
WIDE (INTERSPECIFIC AND INTERGENERIC) HYBRIDIZATION IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.): A TOOL FOR CREATION OF GENETIC VARIABILITY AND SELECTION OF DESIRED TRAITS	598
AGRO-MORPHOLOGICAL DIVERSITY OF TUNISIAN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	599
MOLECULAR STUDIES OF RESISTANCE MECHANISMS IN SUNFLOWER AGAINST <i>OROBANCHE CUMANA</i> WALLR.	600
THE RESISTANCE OF ADVANCED HIGH OLEIC RESTORER LINES AND THE EVALUATION OF THEIR HYBRDS' YIELD TRAITS.....	607
MOLECULAR GENETICS.....	608
PROTEOMIC RESPONSE OF SUNFLOWER TO DROUGHT STRESS	609
APPROACHES FOR IMPROVEMENT OF RESISTANCE TO POWDERY MILDEW IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.).....	613
COMPARISON OF CYTOPLASMIC MALE STERILITY BASED ON PET1 AND PET2 CYTOPLASM IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	620
IDENTIFICATION OF <i>HADILLA</i> , <i>HAGID1</i> AS WELL AS <i>HASLEEPLY</i> AND <i>HASNEEZY</i> GENES INVOLVED IN GIBBERELLIN SIGNALING IN SUNFLOWER	630
QUANTITATIVE DETERMINATION OF SUNFLOWER IN MIXED CONCENTRATE FEEDS BY REAL TIME PCR.....	640
EVALUATION OF WRKY AND MYB TRANSCRIPTION FACTORS IN SOME DOWNY MILDEW INFECTED SUNFLOWER LINES; MICROARRAY DATA ANALYSIS	641
DE NOVO SEQUENCING OF THE <i>HELIANTHUS ANNUUS</i> AND <i>OROBANCHE CUMANA</i> GENOMES.....	642
IN VITRO POLLEN VIABILITY IN SOME WILD TYPE SUNFLOWER GENOTYPES (<i>HELIANTHUS SPP</i>).....	643
CHARACTERIZATION OF SUNFLOWER INBRED LINES WITH HIGH OLEIC ACID CONTENT BY DNA MARKERS... 644	
GENETIC ENGINEERING STUDIES ON SUNFLOWER	651
MAPPING OF A BROOMRAPE RESISTANCE GENE IN SUNFLOWER LINE LIV-17	659
SCREENING OF THE PRESENCE OF OL GENE IN NS SUNFLOWER COLLECTION	660
SEASONAL TIME-COURSE OF EXPANSIN EXPRESSION IN FLOWERS AND GROWING GRAINS OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.).....	667
CHARACTERISATION AND MAPPING OF A LOCUS CONTROLLING LIGHT-YELLOW RAY FLORETS IN SUNFLOWER.....	677
EXPRESSION PROFILES OF DROUGHT INDUCED WRKY TRANSCRIPTION FACTORS IN SOME SUNFLOWER CULTIVARS; MICROARRAY DATA ANALYSIS	678
HIGH THROUGHPUT GENOTYPING TOOLS IN SUNFLOWER.....	679
MAS SELECTION ON OLEIC TYPE SUNFLOWER BREEDING	680
DNA MARKER DETECTION OF DOWNY MILDEW (<i>PLASMOPARA HALSTEDII</i>) RESISTANCE IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	681
THE MOLECULAR GENETIC DIVERSITY OF THE BROOMRAPE (<i>OROBANCHE CUMANA</i> WALLR.) POPULATIONS OF TURKEY.....	682
THE DEVELOPMENTAL FEATURES OF THE OVULE AND EMBRYO SAC IN THE HERMAPHRODITE FLOWERS OF <i>HELIANTHUS ANNUUS</i> L.	683
BIOTIC AND ABIOTIC STRESS TOLERANCE.....	685
EVALUATION OF SUNFLOWER GENOTYPES TO STEM ROT CAUSED BY <i>SCLEROTINIA SCLEROTIORUM</i> UNDER FIELD CONDITIONS	686
ADVANCES IN HOST PLANT RESISTANCE TO SUNFLOWER INSECT PESTS IN NORTH AMERICA.....	687
DISTRIBUTION OF <i>PLASMOPARA HALSTEDII</i> PATHOTYPES IN HUNGARY.....	688
THE EFFECTS OF APPLIED HERBICIDES ON YIELD AND OIL QUALITY COMPONENTS OF TWO OLEIC AND TWO LINOLEIC SUNFLOWER.....	689

GENETIC CHARACTERIZATION OF THE INTERACTION BETWEEN SUNFLOWER AND <i>OROBANCHE CUMANA</i>	701
ISOLATION AND IDENTIFICATION OF PATHOGEN OF SUNFLOWER <i>FUSARIUM</i> WILT.....	702
PCR COMBINED WITH GFP TAGGED <i>VERTICILLIUM DAHLIAE</i> CONFIRMED THE SEEDS TRANSMISSION OF SUNFLOWER <i>VERTICILLIUM</i> WILT	703
RAPID INVITRO SCREENING OF SUNFLOWER GENOTYPES FOR MOISTURE STRESS TOLERANCE USING PEG-6000.....	704
GENOME-WIDE ASSOCIATION OF OIL YIELD PLASTICITY TO DROUGHT, NITROGEN AND CHILLING STRESSES IN SUNFLOWER	715
BREEDING FOR SUNFLOWER HYBRIDS ADAPTED TO CLIMATE CHANGE: THE SUNRISE COLLABORATIVE AND MULTI-DISCIPLINARY PROJECT	716
CONTROL OF <i>VERTICILLIUM DAHLIAE</i> CAUSING SUNFLOWER WILT USING <i>BRASSICA</i> COVER CROPS	717
STUDY OF THE GENOMIC DIVERSITY OF <i>VERTICILLIUM SP.</i> CAPABLE OF COLONIZING SUNFLOWER. HOW KNOWLEDGE OF PATHOGEN GENETIC STRUCTURE CAN BE COMBINED WITH CLASSICAL BREEDING APPROACHES TO GUIDE IT	726
EVALUATION OF SUNFLOWER (<i>HELIANTHUS ANNUUS L.</i>) HYBRIDS FOR PHOTOTHERMAL UNITS ACCUMULATION, OIL YIELD, OIL QUALITY AND YIELD TRAITS UNDER SPRING PLANTING CONDITIONS OF HARIPUR, PAKISTAN	727
DETERMINING NEW AGGRESSIVE BROOMRAPE INFESTATION IN MEDITERRANEAN REGION OF TURKEY	728
STUDY OF <i>OROBANCHE CUMANA</i> GENETIC DIVERSITY.....	734
REACTION OF SUNFLOWER (<i>HELIANTHUS ANNUUS L.</i>) LINES TO DROUGHT STRESS BASED ON TOLERANCE INDICES.....	735
CADMIUM-POTASSIUM INTERRELATIONSHIPS IN SUNFLOWER (<i>HELIANTHUS ANNUUS L.</i>)	736
RESPONSE TO SUNFLOWER (<i>HELIANTHUS ANNUUS L.</i>) PLANT AT EARLY GROWTH STAGE TO CADMIUM TOXICITY	737
THE VIRULENCE OF <i>PLASMOPARA HALSTEDII</i> IN THE SOUTHERN REGIONS OF RUSSIAN FEDERATION.....	738
QUANTIFICATION OF DROUGHT TOLERANCE LEVELS OF SUNFLOWER INBRED LINES BY MEANS OF CHLOROPHYLL-A FLUORESCENCE	744
PHYSIOLOGICAL VARIABILITY OF SUNFLOWER DOWNY MILDEW CAUSAL AGENT, <i>PLASMOPARA HALSTEDII</i> , IN IRAN.....	758
CHANGES IN THE PATHOGENIC COMPOSITION, ATTACKING THE OIL SUNFLOWER IN BULGARIA	759
VARIATION IN AGGRESSIVENESS OF <i>PHOMA MACDONALDII</i> ISOLATES FROM THREE BALKAN COUNTRIES AND UKRAINE	764
SUNFLOWER DISEASES IN NORTHERN GREECE	769
HELIPHEN : A HIGH-THROUGHPUT PHENOTYPING PLATFORM TO CHARACTERIZE PLANT RESPONSES TO WATER STRESS FROM SEEDLING STAGE TO SEED SET	770
INDUCED RESISTANCE IN SUNFLOWER AGAINST WHITE ROT (<i>SCLEROTINIA SCLEROTIORUM</i> (LIB.) DE BARY) AND DOWNY MILDEW (<i>PLASMOPARA HALSTEDII</i> (FARL.) BERL. ET DE TONI).....	771
A REEVALUATION OF MYCELIOGENIC GERMINATION OF SCLEROTIA FOR <i>SCLEROTINIA SCLEROTIORUM</i> STRAIN SUN-87	772
SEED PRIMING APPLICATION EFFECT ON ALLEVIATION OF DROUGHT STRESS IMPACTS DURING GERMINATION IN SUNFLOWER HYBRIDS (<i>HELIANTHUS ANNUUS L.</i>).....	773
THE BEHAVIOUR OF SOME SUNFLOWER CULTIVARS TO THE MAJOR PEST AGENTS IN THE SOUTH-EASTERN AREA OF ROMANIA.....	781
APPLICATION OF GEOSTATISTICS ON PHENOMIC AND PHENOTYPING DATA: AN A POSTERIORI DIAGNOSTIC OF DISEASE SPATIAL PATTERN UNDER NATURAL INFESTATION	787
IMPROVING GENE-TO-PHENOTYPE PREDICTIONS WITH CROP SIMULATION MODELS: WORK IN PROGRESS FOR SUNFLOWER YIELD STABILITY UNDER WATER DEFICIT	788
INVESTIGATIONS AND THE DESCRIPTION OF VIRUS DISEASES IN SUNFLOWER GROWING AREAS IN THE TRAKYA REGION OF TURKEY	789
IDENTIFICATION OF GENETIC AND MOLECULAR FACTORS INVOLVED IN SUNFLOWER PHYSIOLOGICAL RESPONSES TO ENVIRONMENTAL VARIATIONS: AN ARCHETYPE OF INTEGRATIVE SYSTEMS BIOLOGY APPROACH	790
EXPLOITATION OF THE KNOWLEDGE ON OOMYCETE EFFECTORS TO DRIVE THE DISCOVERY OF DURABLE DISEASE RESISTANCE TO DOWNY MILDEW IN SUNFLOWER	791
SUNFLOWER BREEDING STRATEGY FOR RESISTANCE TO DOWNY MILDEW DISEASE IN INDIA.....	792
THE BEHAVIOR OF SUNFLOWER HYBRIDS IN DIFFERENT ENVIRONMENTAL CONDITIONS IN ROMANIA	798
HISTORY AND PRESENT STATE OF DOWNY MILDEW IN ARGENTINA	799
A REVIEW ON THE SEED-BORNE MICROFUNGI OF SUNFLOWER (<i>HELIANTHUS ANNUUS L.</i>).....	804
EPIPHYTIC DISEASE OF SUNFLOWER STEM CANKER IN ARGENTINA	805
INVESTIGATIONS AND THE DESCRIPTION OF VIRUS DISEASES IN SUNFLOWER GROWING AREAS IN THE TRAKYA REGION OF TURKEY	808
BIPOLARIS AUSTRALIENSIS ON SUNFLOWER IN RUSSIA	809
METABOLOMIC PROFILING OF SUNFLOWER SEEDS IN RESPONSE TO WATER STRESS DURING GERMINATION.....	810

CROP PRODUCTION AND MANAGEMENT.....	811
USE OF POLYMER HYDROGEL IN SOIL MOISTURE CONSERVATION FOR SUNFLOWER CULTIVATION IN RAINFED SITUATIONS OF NORTHERN KARNATAKA, INDIA: A CASE STUDY	812
EFFECTS OF MICRONUTRIENTS ON OIL QUALITY OF SUNFLOWER	819
(<i>HELIANTHUS ANNUUS</i> L.).....	819
PERFORMANCE OF SUNFLOWER HYBRIDS IN BLACK COTTON SOILS OF NORTHERN KARNATAKA, INDIA	826
CONFECTIONARY SUNFLOWER IN IRAN	839
RELATIONSHIPS BETWEEN GERMINATION AND VIGOR TESTS WITH FIELD EMERGENCE OF SUNFLOWER IN IRAN	840
GREEN AND BROWN BRIDGES AID SURVIVAL OF MULTIPLE DIAPORTHE/PHOMOPSIS SPECIES WITH A RANGE OF VIRULENCES ON SUNFLOWER, SOYBEANS, MUNGBEANS AND OTHER CROPS IN AUSTRALIA.....	844
PULSAR® PLUS AND EUROLIGHTNING® PLUS - HERBICIDES FOR ENHANCED WEED CONTROL IN CLEARFIELD® PLUS SUNFLOWER	845
CHEMICAL BROOMRAPE (<i>OROBANCHE CUMANA</i>) CONTROL IN CLEARFIELD® SUNFLOWER WITH DIFFERENT IMAZAMOX CONTAINING HERBICIDE FORMULATIONS	846
THE EFFECT OF CLIMATE FACTORS ON THE YIELD OF SUNFLOWER AND SUNFLOWER YIELD PREDICTIONS BASED ON CLIMATE CHANGE PROJECTIONS: EXAMPLE OF MARMARA REGION	847
NEW SEED TREATMENT SOLUTIONS FOR PLASMOSPORA RESISTANCE MANAGEMENT IN SUNFLOWER	858
MODELING SUNFLOWER FUNGAL COMPLEX TO HELP DESIGN INTEGRATED PEST MANAGEMENT STRATEGIES	859
APPROPRIATE NITROGEN (N) AND PHOSPHORUS (P) FERTILIZER REGIME FOR SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) IN THE HUMID TROPICS.....	860
INTERACTIVE EFFECTS OF DIFFERENT INTRA-ROW SPACING AND NITROGEN LEVELS ON YIELD AND YIELD COMPONENTS OF CONFECTIONERY SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) GENOTYPE (ALACA) UNDER ANKARA CONDITIONS	870
EFFECTS OF DIFFERENT ORGANOMINERAL AND INORGANIC COMPOUND FERTILIZERS ON SEED YIELD AND SOME YIELD COMPONENTS OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	881
EFFECTS OF MICRO NUTRIENTS (Fe, Zn, B AND Mn) ON YIELD AND YIELD COMPONENTS OF TWO SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) CULTIVARS IN URMIA CONDITION	886
GLOBAL CHANGE ADAPTATION: WHAT FUTURE FOR SUNFLOWER CROPS AND PRODUCTS? A FORESIGHT STUDY FOR OILSEED CHAINS AT 2030 HORIZON.....	891
ESCAPE TO TINY BUG (<i>NYSIUS SIMULANS</i> STÅL) ATTACK ACROSS PLANTING DATE ADJUSTMENT IN SUNFLOWER HYBRID SEED CROPS FROM SOUTHERN BUENOS AIRES PROVINCE, ARGENTINE.	901
SUSTAINABILITY OF SUNFLOWER PRODUCTION FROM THE POINT OF PRODUCERS	907
EVALUATION OF APPLICATIONS OF THE SUPERVISION PRICE AND CUSTOMS DUTY IN SUNFLOWER FOREIGN TRADE	908
DETERMINATION OF THE YIELD AND YIELD COMPONENTS PERFORMANCE OF SOME SUNFLOWERS (<i>HELIANTHUS ANNUUS</i> L.) UNDER RAINFED CONDITIONS	909
MICROBIAL DRESSING OF SUNFLOWER SEEDS WITH TRICHODERMA HARZIANUM KUEN 1585.....	917
CURRENT SITUATION, PROBLEMS AND SOLUTIONS OF SUNFLOWER IN THE CENTRAL ANATOLIAN REGION.....	918
NITROGEN ECONOMY THROUGH BIO-FERTILIZER IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.).....	925
THE EVALUATION OF SUNFLOWER HARVEST WASTE AS SILAGE FEED.....	926
PATH ANALYSES OF YIELD IN SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.) PARENTAL LINES.....	927
EFFECT OF THE PLANT DENSITY AND FOLIAR FERTILIZATION ON THE YIELD FROM NEW BULGARIAN HUBRIDS OF SUNFLOWER (<i>HELIANTHUS ANNUUS</i> L.)	933
EFFECT OF SOWING DATE ON HEAD DIAMETER IN SUNFLOWER	941
EFFICACY OF <i>TRICHODERMA</i> SPP. ISOLATES AGAINST <i>SCLEROTINIA SCLEROTIUM</i> ON SUNFLOWER SEEDLINGS	942
EFFECT OF BIOSTIMULATORS ON SEED QUALITY, YIELD AND OIL CONTENT IN SUNFLOWER	948
INSECT MONITORING IN SUNFLOWER CROPS (<i>HELIANTHUS ANNUUS</i>) IN NORTHERN GREECE (2010-2015)	958
INFLUENCE OF SEED SIZE GRADE ON SUNFLOWER PLANT HIGH	959
AGRONOMIC PERFORMANCE OF SUNFLOWER CULTIVARS IN CAMPO NOVO DO PARECIS - MT, BRAZIL	965
OR MASTER APP, THE UNIC SMARTPHONE APPLICATION TO FIGHT AGAINST <i>OROBANCHE CUMANA</i>	972
PICTOR® – A BROAD-SPECTRUM FUNGICIDE FOR SUNFLOWER.....	973
PATHOGENICITY AND MOLECULAR CHARACTERIZATION OF AN INTERNATIONAL COLLECTION OF <i>VERTICILLIUM DAHLIAE</i> , PATHOGEN OF SUNFLOWER.....	974
SOCIO-ECONOMIC IMPACTS OF NEW SUNFLOWER IDEOTYPES	975
SUNFLOWER YIELD RESPONSE TO CROP DENSITY UNDER CLIMATIC UNCERTAINTY: COUPLING AN EXPERIMENTAL AND A SIMULATION APPROACH	976

FERTILIZATION OF SUNFLOWER, ACCORDING TO DATA FROM FOUR-CROP ROTATION LONG-TERM EXPERIMENT	977
RELATIONSHIP BETWEEN SEED YIELD AND SOME QUALITATIVE TRAITS OF SUNFLOWER (<i>HELIANTHUS ANNUUS L.</i>) UNDER DIFFERENT IRRIGATION REGIMES AND FERTILIZER TREATMENTS.....	982
LONG TERM CHANGES IN GERMINATION AND VIGOUR OF SUNFLOWER HYBRID SEEDS HARVESTED AFTER CHEMICAL DESICCATION WITH PARAQUAT	986
VARIABILITY OF THE LIFE CYCLE ASSESSMENT RESULTS OF SUNFLOWER ACCORDING TO DIFFERENT AGRICULTURAL PRACTICES....	987
STUDIES OF SOME HYBRID SUNFLOWER(<i>HELIANTHUS ANNUUS L.</i>) CULTIVARS FOR THEIR YIELD AND YIELD COMPONENTS IN THRACE AREA.....	988
TOWARDS DEVELOPMENT OF SUNFLOWER IN WEST AFRICA: BURKINA FASO AND MALI	989
MICROMYCETES ASSOCIATED WITH SUNFLOWER SEEDS DURING STORAGE PERIOD.....	993
PROJECTION OF SUNFLOWER AND SUNFLOWER OIL PRODUCTION AND FOREIGN TRADE	1001
SUNEO: TECHNOLOGY FOR YIELD PROTECTION	1002
RESULTS REGARDING BIOMASS YIELD AT SUNFLOWER UNDER DIFFERENT TECHNOLOGICAL CONDITIONS	1003
RESULTS REGARDING THE CORRELATION OF THE GRAIN YIELD WITH THE YIELD OF ABOVE-GROUND BIOMASS AT SUNFLOWER CROP	1010
TOWARD REAL TIME INSPECTION OF QUALITY IN SUNFLOWER SEEDS: MACHINE VISION	1018
POTENTIAL OF HYPERSPECTRAL IMAGE PROCESSING FOR CLASSIFICATION AND QUALITY EVALUATION OF SUNFLOWER SEEDS	1019
SOME MORPHOLOGICAL CHARACTERISTICS OF CONFECTIONARY SUNFLOWER GENOTYPES OBTAINED THROUGH SELECTION BREEDING	1020
A PRELIMINARY STUDY ON CONTROL OF SUNFLOWER DOWNY MILDEW (<i>PLASMOPARA HALSTEDII</i>) WITH CULTURE FILTRATES OF ANTAGONISTIC FUNGI.....	1024
AGRONOMIC PERFORMANCE OF SUNFLOWER (<i>HELIANTHUS ANNUUS L.</i>) IN AN ORGANIC CROP ROTATION SYSTEM IN THE HUMID TROPICS	1025
OIL AND MEAL QUALITY	1032
LESSONS FROM TEN YEARS OF AN INTERPROFESSIONAL SURVEY PLAN ON OILSEEDS FOOD SAFETY	1033
THE EFFECTS OF VACUUM AND ATMOSPHERIC DEEP-FAT FRYING PROCESS ON TOTAL FRYING-USE TIME OF SUNFLOWER OIL AND ON FRENCH FRIES QUALITY.....	1038
EFFECT OF CURCUMIN NANOPARTICLES ON OXIDATIVE STABILITY OF SUNFLOWER OIL-IN-WATER EMULSIONS.....	1039
DETERMINATION OF TEXTURAL, RHEOLOGICAL PROPERTIES AND SFC, SMP VALUES OF OLEOGELS PREPARED USING SUNFLOWER OIL.....	1040
ASSESSMENT OF SUNFLOWER OIL ADULTERATION.....	1041
EFFECT OF DIFFERENT STORAGE CONDITIONS ON QUALITY PROPERTIES OF RAW AND ROASTED SUNFLOWER KERNELS.....	1048
QUALITY CHARACTERISTICS OF ROASTED SUNFLOWER SEEDS DURING STORAGE.....	1049
ACCEPTABILITY OF CHAPATI MADE WITH SUPPLEMENTATION OF SUNFLOWER (<i>HELIANTHUS ANNUS L.</i>) SEED MEAL	1050
SOME ANTINUTRIENTS AND IN VITRO PROTEIN DIGESTIBILITY OF HOME PROCESSED SUNFLOWER SEED MEAL.....	1051
CONTENT AND OIL PRODUCTIVITY IN SUNFLOWER GENOTYPES PRODUCED IN CAMPO NOVO DO PARECIS – MT, BRAZIL.....	1052
DETERMINATION OF FATTY ACID COMPOSITION FOR FRYING SUNFLOWER OIL USING GAS CHROMATOGRAPHY.....	1058
BIOPellet PRODUCTION FROM WASTE MATERIALS OF THE SUNFLOWER IS A MAJOR INDUSTRIAL PLANT	1063
FACTORS AFFECTING THE NUTRIENT COMPOSITION OF SUNFLOWER MEAL	1064
EFFECT OF HIGH OLEIC SUNFLOWER OIL INCLUDING OLEOGEL ON THE TEXTURAL AND SENSORY PROPERTIES OF CAKE.....	1065
SUNFLOWER OIL QUALITY SYMPOSIUM	1066
LESSONS FROM TEN YEARS OF AN INTERPROFESSIONAL SURVEY PLAN ON OILSEEDS FOOD SAFETY	1067
THE EFFECTS OF VACUUM AND ATMOSPHERIC DEEP-FAT FRYING PROCESS ON TOTAL FRYING-USE TIME OF SUNFLOWER OIL AND ON FRENCH FRIES QUALITY.....	1072
EFFECT OF CURCUMIN NANOPARTICLES ON OXIDATIVE STABILITY OF SUNFLOWER OIL-IN-WATER EMULSIONS.....	1073
DETERMINATION OF TEXTURAL, RHEOLOGICAL PROPERTIES AND SFC, SMP VALUES OF OLEOGELS PREPARED USING SUNFLOWER OIL.....	1074
AFLATOXIN CONTAMINATION IN SUNFLOWER OIL	1075
APPLICATION OF COLD NEUTRALIZATION IN SUNFLOWER OIL REFINING	1080
COMPARISON OF GAS CHROMATOGRAPHY AND NEAR-INFRARED REFLECTANCE SPECTROSCOPY METHODS FOR THE DETERMINATION OF FATTY ACID COMPOSITION OF SUNFLOWER SEED	1081

AROMA DETERMINATION OF A REFINED SUNFLOWER SEED OIL BY GAS CHROMATOGRAPHY-MASS SPECTROMETRY USING DIFFERENT EXTRACTION METHODS	1086
THE EFFECT OF THE ESSENTIAL OIL FROM <i>CITRUS AURANTIUM</i> AS A SOURCE OF NATURAL ANTIOXIDANT IN SUNFLOWER OIL	1087
CHARACTERIZATION OF SUNFLOWER OIL OLEOGELS PREPARED WITH BEESWAX AND SUNFLOWER WAX.....	1092
QUALITY CHARACTERISTICS OF THE OILS OBTAINED BY COLD PRESSING TECHNIQUE	1093
EFFECTS OF TEMPERATURE AND VACUUM PARAMETERS APPLIED DURING DEODORIZATION STEP ON SUNFLOWER OIL QUALITY	1094
DIFFERENT EXTRACTION METHODS FOR SUNFLOWER AND OTHER EDIBLE OILS	1095
FRYING PERFORMANCE OF HIGH OLEIC SUNFLOWER OILS.....	1096
COMPARISON OF PHYSICAL AND CHEMICAL PROPERTIES OF SUNFLOWER AND DIFFERENT VEGETABLE OILS BIODIESEL	1097
LC-DAD/ESI-MS/MS CHARACTERIZATION OF PHENOLIC COMPOUNDS OF SUNFLOWER OIL	1098
COMPARISON OF ENZYMATIC PROCESS FOR BIODIESEL PRODUCTION FROM SUNFLOWER OIL	1106
ASSESSMENT OF SUNFLOWER OIL ADULTERATION.....	1107
EFFECT OF DIFFERENT STORAGE CONDITIONS ON QUALITY PROPERTIES OF RAW AND ROASTED SUNFLOWER KERNELS.....	1114
QUALITY CHARACTERISTICS OF ROASTED SUNFLOWER SEEDS DURING STORAGE.....	1115
ACCEPTABILITY OF CHAPATI MADE WITH SUPPLEMENTATION OF SUNFLOWER (<i>HELIANTHUS ANNUS L.</i>) SEED MEAL	1116
SOME ANTINUTRIENTS AND IN VITRO PROTEIN DIGESTIBILITY OF HOME PROCESSED SUNFLOWER SEED MEAL.....	1117
CONTENT AND OIL PRODUCTIVITY IN SUNFLOWER GENOTYPES PRODUCED IN CAMPO NOVO DO PARECIS – MT, BRAZIL.....	1118
DETERMINATION OF FATTY ACID COMPOSITION FOR FRYING SUNFLOWER OIL USING GAS CHROMATOGRAPHY.....	1124
DETECTION OF REFINED MAIZE AND CANOLA OIL IN COLD-PRESSED SUNFLOWER OIL BY USING RAMAN SPECTROSCOPY.....	1129
DETERMINATION OF REFINED SUNFLOWER OIL IN COLD-PRESSED SUNFLOWER OIL USING RAMAN SPECTROSCOPY	1130
MONITORING THE CHANGES IN COLD-PRESSED SUNFLOWER OIL DURING HEATING BY RAMAN SPECTROSCOPY	1131
APPLICATION OF ARTIFICIAL NEURAL NETWORK ON PREDICTION OF MOISTURE CONTENT OF THE DEEP-FAT FRYING OF BEEF MEATBALLS IN SUNFLOWER OIL	1132
DEEP FRYING QUALITY OF HIGH-OLEIC SUNFLOWER OIL.....	1133
THE DIFFERENCES BETWEEN LINOLEIC AND HIGH-OLEIC SUNFLOWER OIL.....	1134
AROMA PROFILE AND SENSORY CHARACTERIZATION OF OXIDIZED SUNFLOWER OIL	1135
APPLICATION OF SUPERCRITICAL CARBON DIOXIDE FOR SUNFLOWER OIL EXTRACTION.....	1136
EFFECT OF ENZYMATIC INTERESTERIFICATION ON OXIDATIVE STABILITY OF SUNFLOWER OIL	1137
EFFECT OF THE DEEP-FAT FRYING PROCESS ON AROMA COMPOUNDS OF	1138
SUNFLOWER SEED OIL	1138
BIOPELLET PRODUCTION FROM WASTE MATERIALS OF THE SUNFLOWER IS A MAJOR INDUSTRIAL PLANT	1144
FACTORS AFFECTING THE NUTRIENT COMPOSITION OF SUNFLOWER MEAL	1145
EFFECT OF HIGH OLEIC SUNFLOWER OIL INCLUDING OLEOGEL ON THE TEXTURAL AND SENSORY PROPERTIES OF CAKE.....	1146
XYLOSE PRODUCTION FROM PRETREATED SUNFLOWER STALKS.....	1147
NATURALLY BLEACHED VEGETABLE OIL, SHAPED BY ONE ALL-ROUND SOLUTION: TONSIL®	1149
ISC2016 PARTICIPATION LIST.....	1150
OUR SPONSORS.....	1184

EFFICACY OF *TRICHODERMA* SPP. ISOLATES AGAINST *SCLEROTINIA SCLEROTIUM* ON SUNFLOWER SEEDLINGS

Sonja TANČIĆ ŽIVANOV^{1*}, Siniša JOCIĆ¹, Vladimir MIKLIČ¹

¹*Institute of Field And Vegetable Crops Novi Sad, Maksima Gorkog, Novi Sad, Serbia*

*e-mail: sonja.tancic@nsseme.com

ABSTRACT

Trichoderma species are well known as effective antagonists to a variety of soil fungal pathogens. The aim of this research was to test the ability of *Trichoderma* spp. isolates, which previously indicated antagonistic activity (Tančić et al. 2012), to protect sunflower seedlings from *Sclerotinia sclerotiorum*. Ten *Trichoderma* spp. isolates obtained from different soil types and localities in Vojvodina province and one *S. sclerotiorum* isolate from sunflower grown at Rimski Šančevi (Serbia) were used in research. Biological efficacy was tested on 100 sunflower seeds treated with *Trichoderma* spp. suspensions (1×10^6) in two different treatments: T-30 (modified Mukhtar et al., 2012) and T-1.2 (Maslienko, 2005). *Trichoderma*-coated seeds were placed in four replicates on wet filter paper in Petri dishes. Next to each *Trichoderma*-coated seed the 5 mm² plug of *S. sclerotiorum* mycelia was placed, and incubated under the optimal laboratory conditions. Seeds treated with sterile distilled water with pathogen and without it were used as a positive and negative control, respectively. After seven days, biological efficacy of *Trichoderma* spp. isolates was assessed and calculated according to Liu et al. (2009). According to obtained results, biological efficacy of all tested *Trichoderma* isolates was statistically significant as compared to the positive control in both treatments. Good antagonism with over 50% of biological efficacy was registered in 8 isolates in T-30, and 3 isolates in treatment T-1.2. Three *Trichoderma* isolates which showed biological efficacy over 50% in both treatments can be considered as potential biocontrol agents which should be included in further more comprehensive research.

Key words: *Trichoderma*, *Sclerotinia sclerotiorum*, Antagonism, Sunflower

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important annual species grown in Serbia mostly for its edible oil. Areas grown under sunflower were around 170 000 hectares with the expected yield of 422 000 tones and sunflower oil production of 139 000 tones in economical year 2015/2016 (Chamber of Commerce and Industry of Serbia, 2016).

Farmers around the world are familiar with *S. sclerotiorum* (Lib.) de Bary as a threat to numerous crops such as sunflower, soybean, oilseed rape, edible dry bean, chickpea, peanut, dry pea, lentils and various vegetables as well. Occurrence of diseases caused by *S. sclerotiorum* on sunflower is influenced by genotype and weather conditions. Moist and cold weather conditions prevailing in temperate climate regions favours *S. sclerotiorum* development. In Serbia, weather conditions favoured economically important *Sclerotinia* development on sunflower head in 1999 and 2005 with diseased plants even over 60% (Maširević and Forgić, 2000; Maširević and Dedić, 2006). Diseases caused by this fungus can

appear during the whole sunflower growing season, and yield loss depends on the sunflower development stage in which the disease occurs. Sunflower plants infected at the beginning of flowering stage can lose up to 98% of their potential yield, while plants infected eight weeks after flowering can lose not more than 12% of their potential yield (Maširević & Gulya 1992). The major control method for *Sclerotinia* diseases has been fungicide application in combination with host resistance.

Considering growing demand for organic food production, biocontrol of such cosmopolitan and devastating pathogen is a big challenge. The use of biofertilizers and biopesticides is an alternative for sustaining high eco-friendly production. Integrated control is facilitated by the fact that *Trichoderma* species are resistant to most chemical pesticides (Harman, 2011; FRAC, 2016). *Trichoderma* species have been known since 1930s (Weindling, 1932), but since 1990s their usage in commercial agriculture has been increased (Harman 2004, 2011). So far, *Trichoderma* species have been known as effective on nutrient utilization with high reproductive potential which allow them to survive under unfavourable conditions and makes them very competitive. Presence of great variety of lytic enzymes (cell-wall degrading enzymes) and secondary metabolites (gliotoxin, gliovirin, viridin, viridiol etc.) makes *Trichoderma* strongly aggressive to broad range of phytopathogenic fungi (Vinale et al., 2008). The main biocontrol mechanisms of *Trichoderma* species, when direct confrontation with pathogen occurs, are mycoparasitism and antibiosis (Howel, 2003). Another mechanism which is quite effective as well, but do not consider direct confrontation with the pathogen, is competition for soil nutrients and space. Additionally, *Trichoderma* species are known as well as plant growth promoter agents and promoters of plant defense mechanisms (Shoresh et al., 2010; Harman, 2011). *Trichoderma* colonizes roots and provides at least season-long benefits to plants, although it can be even for life because the best strains fully colonize roots as they grow (Harman 2000). So far it is recorded that *Trichoderma* species improve growth of lettuce, tomato, pepper, wheat, maize, soybean, chilli (Vinale et al., 2004; Tucci et al., 2011; Sukla et al., 2015; Maisuria and Patel, 2009; Asaduzzaman et al., 2010). Also, *Trichoderma* spp. is stimulating defense responses in its host plants and is known as one of the best induced systemic resistance (ISR) agents (Shoresh et al., 2010; Shoresh, 2005).

Trichoderma species are mainly soil fungi found in agricultural soils, native prairie, forests, salt marsh, desert soils of all climatic zones, but also in dead plant material, living roots of various plant species, seeds, lake water and air (Monte, 2001). World-wide distribution, fast growth and high spore production make those species easy to find and isolate. After all, one should bear in mind that not all *Trichoderma* strains are effective, most of them are not, and some may even be phytotoxic or pathogenic (Menzies, 1993), so strain selection is of crucial importance. Given that, the aim of this study was to test ability of native Serbian *Trichoderma* strains to protect sunflower seedlings in early stage from pathogen *S. sclerotiorum*.

MATERIAL AND METHODS

Plant and fungal material used: Fungal material was obtained from soil samples originated from different soil types and localities in Serbia, mainly from Vojvodina province. All *Trichoderma* spp. isolates were refined to single-spore according to Leslie and Summerell (2006). Ten isolates which previously indicated good antagonistic activity in dual culture test (Tančić et al., 2012) were selected for this research. Pathogen *S. sclerotiorum* was isolated from diseased sunflower plant at Rimski Šančevi.

Trichoderma isolates' efficacy against *S. sclerotiorum* was tested on sunflower seeds of sterile parental line VL-A-8A.

Preparation of conidia suspension: A conidia suspensions of ten tested *Trichoderma* isolates were prepared from 7-days old isolates by flooding method. Such suspensions were filtered through cheesecloth, and conidial concentrations were adjusted to 10⁶ conidia/ml by Neubauer's haemocytometer. Additionally, suspensions were amended according to Mukhtar et al. (2012) method.

Treatment T-1.2 considered that seeds were treated with 1.2 µl of *Trichoderma* suspension which was equally distributed per g of seeds and air dried on filter paper in Petri plates for 24 hours at room temperature (Маслиенко, 2005). Control was treated with 1.2 µl of sterile distilled water per g of seeds.

Treatment T-30 considered that seeds were dipped in seed-coating suspensions for 30 minutes and air dried on filter paper in Petri plates for 24 hours at room temperature, while sterile distilled water was used as a control.

Biological efficacy test: was done on 100 sunflower seeds treated with *Trichoderma* suspensions of different intensities (T-1.2 and T-30). Treated seeds were germinated in four replicates on double wet filter paper. Next to each sunflower seed, the 5 mm² plug of potato dextrose agar (PDA) with 7-day old micelia of *S. sclerotiorum*, was placed. Seeds treated with sterile distilled water without presence of pathogen *S. sclerotiorum* plugs were used as negative control, while seeds treated with sterile distilled water with presence of *S. sclerotiorum* plugs were used as positive control. Seeds were germinated in growth chamber with 12h photoperiod at 25±1°C. After seven days diseased seedlings and seeds were counted, and biological efficacy of the *Trichoderma* isolate was calculated according to formula (Liu et al. 2009):

$$C (\%) = 100 * (a - b) / a$$

where C is biological efficacy in %, a – number of diseased seeds and seedlings in positive control, and b – number of diseased seeds and seedlings in treatment.

Beside biological efficacy, germination (G) was calculated as well on 7th day of the experiment.

Statistical analyses: All obtained data were analyzed in Statistica 12 using Duncan's test (percentages were previously transformed in ArcSin√%).

RESULTS AND DISCUSSION

Formation of rhizosphere microflora occurs usually in first three days after germination, and its progress in the deeper soil layers follows root growing and stimulates plant exometabolites at the same time (Асартрובה, 2009). This is very important in biocontrol especially because young seedlings are often infected by pathogens in early stage of their development. Due to above mentioned, biological efficacy was estimated in the first days of sunflower germination and expressed as a percentage of protected seeds and seedlings comparing positive control (seeds without *Trichoderma* treatment grown in presence of pathogen *S. sclerotiorum*).

Germination was calculated on 7th day of incubation. Lower germination rates were registered in treatments with lower biological efficacy. Biological efficacy of all tested isolates was statistically significant as compared to the positive control in both treatments. According to obtained results, biological efficacy of tested *Trichoderma* isolates varied from 36 – 68% and 23.8 – 60.6% for treatments T-30 and T-1.2 respectively (Table 1). Excellent

antagonism with over 50% of biological efficacy was registered in 8 isolates in T-30, and 3 isolates in treatment T-1.2 (bold values in Table 1). Three *Trichoderma* isolates – K150, K173 and K174 showed biological efficacy over 50% in both treatments. These are promising results considering that some authors with bacterial antagonist reached biological efficacy against *Fusarium* spp. on sunflower seedlings from 0-36% (Асарова, 2009), while biological efficacy of fungal and bacterial antagonist against *S. sclerotiorum* on sunflower stem under the field conditions was much higher - 54.5-100% (Фирсов et al., 2009). Besides on sunflower, the antagonistic activity of *Trichoderma* spp. against *S. sclerotiorum* was proven on other crops as well. Thus, the application of *T. harzianum* as alignate capsules increased the survival of soybean plants more than 100% and 40% in greenhouse and in the field, respectively (Menendez and Godeas, 1998). Isolates of *T. harzianum* also protected over 80% of tomato, squash and eggplant seedlings inoculated with *S. sclerotiorum* in the greenhouse experiments (Abdullah et al., 2008). Further, *T. virens* significantly reduces the percentage of viable sclerotia and number of apothecia produced (Huang and Erickson, 2008) which can be used for bioregulation of pathogen density in soil.

Table 1. Biological efficacy of two different treatments with *Trichoderma* spp. isolates against *S. sclerotiorum* on sunflower seedlings

Isolate No	T-30		T-1.2	
	C (%)	G (%)	C (%)	G (%)
K114	50.0 ^{ab}	86 ^{ab}	26.2 ^{bc}	78 ^a
K132	36.0 ^b	74 ^a	45.2 ^a	84 ^{ab}
K150	58.0 ^{ac}	94 ^{ab}	58.3 ^a	80 ^{ab}
K160	50.0 ^{ab}	90 ^{ab}	40.5 ^{abc}	77 ^a
K173	56.0 ^{ac}	76 ^a	54.8 ^a	85 ^{ab}
K174	58.0 ^{ac}	86 ^{ab}	60.6 ^a	85 ^{ab}
K175	68.0 ^c	74 ^a	23.8 ^b	91 ^b
K176	59.5 ^a	88 ^{ab}	48.0 ^{ab}	87 ^{ab}
K178	40.0 ^b	90 ^{ab}	42.9 ^{ac}	80 ^{ab}
K179	53.6 ^a	98 ^b	44.0 ^{ab}	87 ^{ab}
- Control	100 ^d	88 ^{ab}	100 ^d	96 ^{ab}
+ Control	0.00 ^e	80 ^{ab}	0.00 ^e	82 ^{ab}

Legend: Values in the columns followed by the same letters are not significantly different ($p < 0.05$) by Duncan's test; Values are average of four replicates;

Beside *S. sclerotiorum*, it has been proven that *Trichoderma* spp. are aggressive to broad range of phytopathogenic fungi – *Rhizoctonia*, *Fusarium*, *Alternaria*, *Ustilago*, *Venturia*, *Colletotrichum*, *Pythium*, *Phytophthora*, *Thielaviopsis*, *Sclerotium cepivorum*, *Sclerotinia minor* etc. (Vinale et al., 2008; Thomas et al., 2004; McLean et al., 2012).

All mentioned above is leading to a conclusion that those perspective isolates from our research could also be good antagonists for some other important sunflower pathogens which should be tested in some further research.

CONCLUSION

Three out of ten tested *Trichoderma* isolates originating from Serbia expressed excellent ability to protect sunflower seedlings from pathogen *S. sclerotiorum* in both treatments. Those isolates can be considered as potential biocontrol agents and should be included in further, more comprehensive, research.

ACKNOWLEDGEMENT

This research was part of the project TR 031025 supported by Ministry of Education, Science and Technological Development of Republic of Serbia.

LITERATURE

- Abdullah M.T., Ali N.Y., Suleman P. (2008): Biological control of *Sclerotinia sclerotiorum* (Lib.) de Bary with *Trichoderma harzianum* and *Bacillus amyloliquefaciens*. *Crop Protection* 27: 1354-1359.
- Asaduzzaman M., Alam M., Islam M.M. (2010): Effect of *Trichoderma* on seed germination and seedling parameters of chili. *J. Sci. Foundation* 8(1&2):141-150.
- Asaturova A.M. (2009): Promising strains of bacteria - producers of microbiological preparations for reducing of sunflower Fusariosis. PhD thesis, Sankt Petersburg (in Russian).
- Bolton M.D., Thomma B.P.H.J., Nelson B.D. (2006): *Sclerotinia sclerotiorum* (Lib.) de Bary: biology and molecular traits of a cosmopolitan pathogen. *Mol. Plant Pathol.* 7(1): 1-16.
- Chamber of Commerce and Industry of Serbia (2016). <http://www.pks.rs/Vesti.aspx?IDVestiDogadjaji=18880> (16.03.2016.)
- Firsov V.F., Chulhancev A.J., Maslienko L.V., Mustafin I.I. (2009): Testing of biological products on the sunflower in Tambov. *Scientific and technical bulletin of All-Russian Scientific Research Institute of oilseeds*, 2(141): 51-55 (in Russian).
- Fungicide Resistance Action Committee (FRAC) 2016 <http://www.frac.info/search?indexCatalogue=frac&searchQuery=Trichoderma&wordsMode=0> (16.03.2016.)
- Harman G.E. (2000): Myths and dogmas of biocontrol. Changes in perceptions derived from research on *Trichoderma harzianum* T-22. *Plant Disease* 84: 377-393.
- Harman G.E. 2011. *Trichoderma* - not just for biocontrol anymore. *Phytoparasitica* 39:103-108.

- Harman G.E., Howell C.R., Viterbo A., Chet I., Lorito M. (2004): *Trichoderma* species – opportunistic, avirulent plant symbionts. *Nature Reviews Microbiology* 2: 43-56.
- Howel C.R. (2003): Mechanisms employed by *Trichoderma* species in the biological control of plant diseases: the history and evolution of current concepts. *Plant disease* 87: 4-10.
- Huang H.C., Erickson R.S. (2008): Factors Affecting Biological Control of *Sclerotinia sclerotiorum* by Fungal Antagonists. *Journal of Phytopathology* 156: 628-634.
- Liu, J.B., G. Gilardi, M.L. Gullino, A. Garibaldi, 2009. Effectiveness of *Trichoderma* spp. obtained from re-used soilless substrates against *Pythium ultimum* on cucumber seedlings. *J Plant Dis Protect* 116(4): 156-163.
- Maisuria K.M., Patel S.T. 2000. Seed germinability, root and shoot length and vigour index of soybean as influenced by rhizosphere fungi. *Karnataka J. Agric. Sci* 22(5): 1120-1122.
- Maslienko L.V. (2005): Elaboration of microbiological methods for sunflower protection. PhD thesis, Krasnodar (in Russian).
- Maširević S., Dedić B. (2006): Masovna pojava bele truleži glavice suncokreta (*Sclerotinia sclerotiorum*) i uticaj na prinos u 2005. godini. *Zbornik radova* 42: 87-98.
- Maširević S., Forgić G. (2000): Sunflower diseases - limiting factor in sunflower production. *Revija Agronomska znanja*, 10 (3-4): 46-50.
- McLean K.L., Braithwaite M., Swaminathan J., Stewart A. (2012): Variability in control of onion white rot by *Trichoderma atroviride* under different disease pressures. *Australasian Plant Pathology* 41: 341-346.
- Menzies J.G. (1993): A strain of *Trichoderma viride* pathogenic to germinating seedlings of cucumber, pepper and tomato. *Plant Pathology* 42: 784-791.
- Monte E. (2001): Understanding *Trichoderma*: Between biotechnology and microbial ecology. *Int. Microbiology* 4: 1-4.
- Mukhtar I., Hannan A., Atiq M., Nawaz A. Impact of *Trichoderma* species on Seed Germination in Soybean/Pak. *J. Phytopathol.* 2012. Vol. 24. No. 2. P. 159-162.
- Shoresh M., Mastouri F., Harman G.E. (2010): Induced systemic resistance and plant responses to fungal biocontrol agents. *Annual Review of Phytopathology* 48: 21-43.
- Shukla N., Awasthi R.P., Rawat L., Kumar J. (2015): Seed biopriming with drought tolerant isolates of *Trichoderma harzianum* promote growth and drought tolerance in *Triticum aestivum*. *Annals of Applied Biology* 166 (2): 171-182.
- Tančić S., Skrobonja J., Lalošević M., Jevtić R. (2012): Antagonism of *Trichoderma* spp. and *Sclerotinia sclerotiorum* *in vitro*. *Proceedings of XIV Plant Protection Symposium and IX Congress on weeds.* 117-118.
- Tucci M., Ruocco M., de Masi L., de Palma M., Lorito M. (2011): The beneficial effect of *Trichoderma* spp. on tomato is modulated by the plant genotype. *Molecular Plant Pathology* 12 (4): 341-354.
- Vinale F., Sivasithamparam K., Ghisalberti E., Marra R., Woo S.L., Lorito M. (2008): *Trichoderma* – plant – pathogen interactions. *Soil Biology & Biochemistry* 40: 1-10.
- Weindling R. (1932): *Trichoderma lingorum* as a parasite of other soil fungi. *Phytopathology* 22: 837-845.