

# 19<sup>TH</sup> INTERNATIONAL SUNFLOWER CONFERENCE



# isc 2016

29 MAY – 3 JUNE, 2016

EDİRNE, TURKEY





# **ISC 2016**



**PROCEEDINGS  
OF  
19<sup>TH</sup> INTERNATIONAL SUNFLOWER  
CONFERENCE**

**29 MAY – 3 JUNE, 2016**

**EDİRNE, TURKEY**

**19<sup>TH</sup> 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 30<sup>th</sup>, 31<sup>st</sup> of May and 1<sup>st</sup> of June 2016. Besides, the field day and the Sightseeing tours are on June 2<sup>nd</sup> – 3<sup>rd</sup> 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
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Sukru TOPARLAK	Edirne Farmer Union	Member
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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
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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**

<b>NAME</b>	<b>INSTITUTION</b>	<b>COUNTRY</b>
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**

<b>SUNDAY, MAY 29<sup>th</sup>, 2016</b>	
14 <sup>00</sup> - 20 <sup>30</sup>	<b>Registration at Hotels and Balkan Congress Center</b>
<b>MONDAY, MAY 30<sup>th</sup>, 2016</b>	
08 <sup>30</sup> - 09 <sup>30</sup>	Registration at Balkan Congress Center
09 <sup>30</sup> - 10 <sup>30</sup>	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 <sup>30</sup> – 11 <sup>00</sup>	Coffee break
11 <sup>00</sup> - 12 <sup>30</sup>	<b>OPENING SESSION:</b> Session Chair: <b>PROF DR MARIA DUCA</b> – Rector of University of Moldova Academy of Science
11 <sup>00</sup> – 11 <sup>40</sup>	<b>Invited Speaker Prof Dr. Dragan Skoric “HISTORY OF SUNFLOWER BREEDING IN THE WORLD”</b>
11 <sup>40</sup> – 12 <sup>20</sup>	<b>Invited Speaker Dr. Lili Qi “MOLECULAR MAPPING OF THE DISEASE RESISTANCE GENES AND ITS IMPACT ON SUNFLOWER BREEDING”</b>
12 <sup>20</sup> – 12 <sup>30</sup>	DISCUSSION
12 <sup>30</sup> – 13 <sup>30</sup>	<b>LUNCH ((Courtesy of Nidera Semillas)</b>

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	<b>GENETIC AND BREEDING</b>	<b>BIOTIC AND ABIOTIC STRESS TOLERANCE</b>	<b>CROP PRODUCTION AND MANAGEMENT</b>	<b>MOLECULAR GENETICS</b>
	(Main Meeting Room)	(2 <sup>nd</sup> Floor Senate Meeting Room)	(2 <sup>nd</sup> Floor Left Meeting Room)	(2 <sup>nd</sup> Floor Right Meeting Room)
	<b>30.05.2016 MONDAY</b>	<b>30.05.2016 MONDAY</b>	<b>30.05.2016 MONDAY</b>	<b>30.05.2016 MONDAY</b>
13 <sup>30</sup> -15 <sup>30</sup>	<i>1<sup>st</sup> Session Chair: CARLOS FEOLI</i>	<i>1<sup>st</sup> Session Chair: DR MARIA JOITA- PACUREANU</i>	<i>1<sup>st</sup> Session Chair: DR VALENTINA ENCHEVA</i>	<i>1<sup>st</sup> Session Chair: DR RENATE HORN</i>
13 <sup>30</sup> -13 <sup>50</sup>	<b>Invited Speaker</b> <b>DR BRANISLAV DOZET</b>	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 <sup>50</sup> -14 <sup>10</sup>	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. ADIREDDO, T. LAMAZE, P. GRIEU
14 <sup>10</sup> -14 <sup>30</sup>	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., SHESHAIAH 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 <sup>30</sup> -14 <sup>50</sup>	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

19<sup>th</sup> International Sunflower Conference, Edirne, Turkey, 2016

	LANGLADE N.			
14 <sup>50</sup> -15 <sup>00</sup>	Discussion	Discussion	Discussion	Discussion
15 <sup>00</sup> -15 <sup>30</sup>	Coffee break	Coffee break	Coffee break	Coffee break
15 <sup>30</sup> -17 <sup>00</sup>	<b>2<sup>nd</sup> Session: Chair: DR VLADIMIR MIKLIC</b>	<b>2<sup>nd</sup> Session: Chair: DR FELICITY VEAR</b>	<b>2<sup>nd</sup> Session Chair: PROF DR GIAN PAOLO VANNOZZI</b>	<b>2<sup>nd</sup> Session Chair: DR PHILIPPE DEBAEKE</b>
15 <sup>30</sup> -15 <sup>50</sup>	Assessment of sunflower germplasm selected for cold tolerance under autumn planting conditions in Morocco - HOUMANAT K., MAZOUZ H., EL FECHTALI M., NABLOUSSI A.	<b>Invited Speaker</b> <b>PROF DR STEVAN MAŠIREVIĆ</b>	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 <sup>50</sup> -16 <sup>10</sup>	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 <sup>10</sup> -16 <sup>30</sup>	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 <sup>30</sup> 16 <sup>45</sup>	Discussion	Discussion	Discussion	Discussion
16 <sup>45</sup> -18 <sup>00</sup>	<b>Poster Session</b>	<b>Poster Session</b>	<b>Poster Session</b>	<b>Poster Session</b>
19 <sup>30</sup> -	<b>Dinner Party (Courtesy of Syngenta)</b>	<b>Dinner Party (Courtesy of Syngenta)</b>	<b>Dinner Party (Courtesy of Syngenta)</b>	<b>Dinner Party (Courtesy of Syngenta)</b>

	31.05.2016 TUESDAY	31.05.2016 TUESDAY	31.05.2016 TUESDAY	31.05.2016 TUESDAY
09 <sup>30</sup> -10 <sup>10</sup>	<b>3<sup>RD</sup> Session Chair: DR OLIVIER COTTET</b>	<b>3<sup>RD</sup> Session Chair: PROF DR STEVAN MASIREVIC</b>	<b>3<sup>RD</sup> Session Chair: DR AMELIA BERTERO DE ROMANO</b>	<b>3<sup>RD</sup> Session Chair: DR DRAGANA MILADINOVIC</b>
09 <sup>30</sup> -09 <sup>50</sup>	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</i> Wilt - JING G. YUAN YUAN Z., GUI Z., JIAN Z., KAI W., JUN Z.	<b>Invited Speaker</b>	Proteomic response of sunflower to drought stress – M. GHAFFARI, M. TOORCHI, M. VALIZADEH
09 <sup>50</sup> -10 <sup>10</sup>	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	<b>DR PHILIPPE DEBAEKE</b>	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 <sup>10</sup> -10 <sup>30</sup>	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 <sup>30</sup> -10 <sup>50</sup>	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 <sup>50</sup> -11 <sup>00</sup>	Discussion	Discussion	Discussion	Discussion
11 <sup>00</sup> -11 <sup>20</sup>	Coffee break	Coffee break	Coffee break	Coffee break
11 <sup>20</sup> -12 <sup>30</sup>	<b>4<sup>th</sup> Session Chair: DR SINISA JOCIC</b>	<b>4<sup>th</sup> Session Chair: DR MICHAEL FOLEY</b>	<b>4<sup>th</sup> Session Chair: DR SUJATHA MULPURI</b>	<b>4<sup>th</sup> Session Chair: PROF DR RISHI BEHL</b>
11 <sup>20</sup> -11 <sup>40</sup>	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	<b>Invited Speaker</b> <b>DR STEPHANE MUNOS</b> De novo sequencing of the <i>Helianthus annuus</i> and <i>Orobanche cumana</i> genomes
11 <sup>40</sup> -12 <sup>00</sup>	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 <sup>00</sup> -12 <sup>20</sup>	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 <sup>20</sup> -12 <sup>30</sup>	Discussion	Discussion	Discussion	Discussion
13 <sup>30</sup> -13 <sup>30</sup>	<b>Lunch (Courtesy of Edirne Farmer Union)</b>	<b>Lunch (Courtesy of Edirne Farmer Union)</b>	<b>Lunch (Courtesy of Edirne Farmer Union)</b>	<b>Lunch (Courtesy of Edirne Farmer Union)</b>
13 <sup>30</sup> -15 <sup>30</sup>	<b>5<sup>th</sup> Session Chair: DR THIERRY ANDRE</b>	<b>5<sup>th</sup> Session Chair: DR ROBERT NEMETH</b>	<b>5<sup>th</sup> Session Chair: PROF DR BENJAMIN BLACKMAN</b>	<b>5<sup>th</sup> Session Chair: PROF DR DEJANA PANKOVIC</b>
13 <sup>30</sup> -13 <sup>50</sup>	<b>Invited Speaker</b> <b>DR MARIA JOITA-PACUREANU</b>  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

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09 <sup>30</sup> -11 <sup>00</sup>	<b>7<sup>th</sup> Session Chair: DR MIGUEL CANTAMUTTO</b>	<b>REGISTRATION</b>		
09 <sup>30</sup> -09 <sup>50</sup>	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	<b>INTERNATIONAL SUNFLOWER OIL QUALITY SYMPOSIUM</b> Opening Ceremony		
09 <sup>50</sup> -10 <sup>10</sup>	New virulences of <i>Orobanche cumana</i> appear in Romania - PARVU N., TEODORESCU A.	<b>Session Chair: PROF DR MEHMET EMIN CALISKAN</b> <b>Invited Speaker</b> <b>Fabrice THURON</b> - "HO Oilseeds and Oils Market: Positioning Sunflower Today and Tomorrow		
10 <sup>10</sup> -10 <sup>30</sup>	Genetic characterization of the interaction between sunflower and <i>Orobanche cumana</i> - LOUARN J., M. C. BONIFACE, POUILLY N., VELASCO L., P. VINCOURT, B.	<b>Invited Speaker</b> <b>Prof Dr Nurhan TURGUT DUNFORD</b> Sunflower Oil: A Premium Oil for Food Applications		



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11 <sup>20</sup> -11 <sup>40</sup>	<b>Invited Speaker</b> <b>DR LAURA F. MAREK</b>	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 <sup>40</sup> -12 <sup>00</sup>	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 <sup>00</sup> -12 <sup>20</sup>	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
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14 <sup>10</sup> -14 <sup>30</sup>	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 <sup>30</sup> -14 <sup>50</sup>	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	
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15 <sup>30</sup> -15 <sup>50</sup>	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 <sup>50</sup> -16 <sup>10</sup>	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	
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09 <sup>30</sup> -12 <sup>00</sup>	Field Day in Trakya Agricultural Research Institute Visiting Demo Plots
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17 <sup>30</sup> -	Free Shopping Time

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**PATH ANALYSES OF YIELD IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)  
PARENTAL LINES**

***Velimir RADIĆ, Jelena OVUKA, Igor BALALIĆ, Nada HLADNI,  
Milan JOCKOVIĆ, Vladimir MIKLIĆ, Siniša JOCIĆ***

*Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad 21000, Serbia,*

[velimir.radic@ifvcns.ns.ac.rs](mailto:velimir.radic@ifvcns.ns.ac.rs)

**ABSTRACT**

Seed yield is very complex trait; it depends on genotype, environmental conditions, on various plant traits etc. Eighteen sunflower commercial parental lines were evaluated for various parameters under field conditions to estimate genetic parameters and path analyses. The ten female and eight restorer line were chosen for the experiment. Observed parameters were seed yield, 1000 seed, seed germination, oil and protein content. Objective of this study was determination of direct and indirect effects by path analysis; to compare given results of path analysis from female lines with results from restorer lines in order to identify research priorities in sunflower breeding. Path coefficient analysis, in observed female lines, indicates that 1000 seed weight has maximum positive and seed germination maximum negative direct effect on yield. In restorer lines, path coefficient analysis indicates that seed germination and 1000 seed weight have negative direct effect on yield, but effect of seed germination was highly significant.

**Key words:** Sunflower parent lines, Seed and yield components, Path coefficient analysis

**INTRODUCTION**

Seed yield is a very complex trait, has low heritability and it is very dependent on environmental conditions. It depends on various plant traits and it is very important for plant breeders to find out the association between the traits themselves and with the seed yield (Škorić, 1974; 2012). The main goal in sunflower breeding is to develop hybrids with high seed yield and high oil content and therefore to improve productivity of this important oil crop (Jocković at al., 2015).

As the aproach proved to be ineffective, numerous researchers (Shankar et al., 2006; Darvishzadeh et al., 2011; Radić at al., 2013) concluded that path-coefficient analyses provided information about direct and indirect effects of the examined characters on seed yield per plant. Yasin and Singh (2010) also concluded that path-coefficient is helpful in partitioning the correlation into direct and indirect effects. In this way, relative contribution of each component character to the yield can be assessed. In other words, path analysis measures direct and indirect contribution of various independent characters to a dependent character. Using path-coefficient analysis, it is easy to determine which yield component influences the yield substantially. These researchers also concluded that with this information, selection can be based on that criterion in limited time (Farhatullah et al., 2006).

This study was conducted in order to obtain information about interrelationship (direct and indirect effects by path analyses) between seed yield and other observed seed characters as well as to identify research priorities in sunflower breeding.

## MATERIAL AND METHODS

Experiment was carried out in field conditions throughout three years on plots where seed production of sunflower parental lines was established. Ten genotypes were examined which represent lines that were based on cytoplasmic male sterility (CMS). All examined genotypes represent parental components of the best-selling sunflower hybrids of the Institute of Field and Vegetable Crops, Novi Sad, Serbia.

The following parameters were studied:

*Seed yield* – upon maturity, 10 plants were picked manually, from different locations on the plot, and seed yield per plant was determined. By the application of previously determined plant density ( $50.000 \text{ plants ha}^{-1}$ ), obtained seed yield per plant was redetermined in  $\text{kg ha}^{-1}$  with 9% of moisture.

Upon seed drying, specimens were purified and cleaned. Seed for determining the remaining observed parameters were picked from the given specimens:

*Seed germination*- Standard laboratory method for seed germination testing was used (ISTA, 2014). Examination of seed germination was repeated 4 times. Each time 100 seeds were used. Germination was determined after 10 days. Only naturally formed germinated seeds were used for determination of this parameter. Germination was expressed in relative values.

*1000 seed weight*- Examination of 1000 seed weight was repeated 4 times. Each time 100 seeds were used. Obtained value was applied to 1000 seed weight and was specified in grams.

*Oil content*- Determined by nuclear - magnetic resonance (NMR) according to Granlund and Zimmerman (1975) and expressed in relative value.

*Protein content*- Determined by standard Kjeldahl method with the help of VAP-50-Gerhardt apparatus. This parameter is also expressed in relative value.

Analysis of variance of two-factorial experiment, simple correlation coefficient and path-coefficient analysis for examined characters were done using GENSTAT computer program.

## RESULTS AND DISCUSSION

The data were processed by the path-coefficient analysis which enabled the partitioning of direct and indirect effects of individual yield components and identification of yield components applicable as selection criteria in sunflower breeding (Table 1 and 2).

Relatively low coefficient of determination ( $R^2$ ) at trait of sterile lines (0.330) and restorer lines (0.211) level give rise to high residual effects (0.818 and 0.888) meaning that besides parameters used in this study other causal variables are also responsible for seed yield.

Seed germination, in both traits, had the highest negative direct effect on seed yield (-0,354). Only differences between these two effects was that in restorer traits this effect was more significant (-0,485). These results are in agreement with the studies of Radić et al. (2013). In the study of indirect effects, the existence of negative indirect effects was determined in sterile lines (seed germination *via* 1000 seed weight) while in restorer lines this effect was determined as positive. In both traits these indirect effects were not significant.

The study of direct effects on seed yield showed that the 1000 seed weight had high positive direct effect (0.339) in sterile lines, while in restorer lines this parameter had also high direct effect on seed yield, but this effect was negative. In the study of indirect effects, the existence of positive not significant indirect effects on seed yield was determined. Škorić

(1974) and Joksimović et al. (1999) concluded that is necessary that 1000 seed weight has negative direct effect on restorer lines, since this restorer plant has a lot of branches (purpose of exciting of restorer is to have a lot of pollen for pollination). These results are in agreement with the studies of Merrien et al. (1982), Marinković (1992) and Dušanić (1998, 2004). These researchers also concluded that 1000 seed weight has higher effect on seed yield than number of filled seed per head and other yield components. Vanishree et al. (1988) and Tahir et al. (2002) concluded that increasing 1000 seed weight may result in higher yield. As opposed to this, Alba and Greco (1978) and Lakshmanrao et al. (1985) reported that 1000 seed weight has significant direct effect on seed yield, but this is, based on their research, a negative effect.

Table 1. Analysis of direct and indirect effects of observed characters on seed yield in sterile lines

Character	Direct effect	Indirect effect:				Total
		Seed germination	1000 seed weight	Oil content	Protein content	
Seed germination	-0.354	-	-0.010	0.015	0.036	-0.313
1000 seed weight	0.339	0.010	-	0.037	0.009	0.395
Oil content	0.221	-0.024	0.057	-	0.010	0.265
Protein content	0.185	-0.068	0.016	0.012	-	0.146

Coefficient of determination  $R^2=0.330$

Oil content had positive direct effect on seed yield and negative indirect effect *via* seed germination on seed yield at both traits. Other indirect effects were positive and also not significant, except indirect effect of oil content *via* 1000 seed weight on seed yield. This effect was negative. Punia and Gill (1994), Husain et al. (1995) and Chikkadevaiah et al. (2002) concluded in their research that oil content had maximum direct effect on seed yield. On the other side, Habib et al. (2007) confirmed positive direct effect of oil content on seed yield. Arshad et al. (2007) and Kaya et al. (2009) found that oil content had negative direct effect on seed yield as well as negative indirect effect *via* plant height.

Protein content had positive direct effect in sterile line traits but also had negative direct effect in restorer line traits. Both effects are not significant. In both traits two negative indirect effects on seed yield were determined. One of them is in sterile line trait *via* seed germination and other one is *via* oil content in restorer line trait. All other indirect effects are positive. All indirect effects are not significant. Jocković et al. (2015) in their research concluded the same.

Table 2. Analysis of direct and indirect effects of observed characters on seed yield in restorer lines

Character	Direct effect	Indirect effect:				Total
		Seed germination	1000 seed weight	Oil content	Protein content	
Seed germination	-0,485*	-	0,112	0,018	0,005	-0,321
1000 seed weight	-0,337	0,162	-	0,006	0,005	-0,164
Oil content	0,153	-0,150	-0,014	-	0,008	-0,003
Protein content	-0,065	0,035	0,026	-0,018	-	-0,022

Coefficient of determination  $R^2=0.211$

## CONCLUSION

Bringing these observed characters into optimal balance with seed yield is one of main principal for succesfull sunflower breeding program. In this report, path coefficient analysis revealed that the greatest improvement in sunflower seed yield can be achieved through selection on seed germination and 1000 seed weight, because they have the highest direct effect on seed yield. Difference between observed parametrs is that effect of seed germination is negative while in 1000 seed weight is positive in sterile line trait and negative in restorer line trait.

Further research should be aimed at observation of the relationship between certain characters of seed quality, with the intention of obtaining high quality sunflower seed.

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