

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**

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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

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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)

	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. ADIREDDO, 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</i> Wilt - JING G. YUAN YUAN Z., GUI Z., JIAN Z., KAI W., JUN Z.	Invited Speaker DR PHILIPPE DEBAEKE	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		Sunflower and climate change in Europe: crop vulnerability, adaptation, and mitigation potential
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. TOMBULOGLU, 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

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		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 Cerenomy		
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

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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
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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	

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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

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**COMBINING ABILITY AND GENETIC COMPONENTS FOR SEED YIELD IN
SUNFLOWER (*HELIANTHUS ANNUUS* L.)**

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ABSTRACT

Being one of the most important oil crops in the world main goals in sunflower breeding are increased seed and oil yield per hectare. Bearing in mind breeding direction and global importance of this oil crop objective of this study was to evaluate general combining ability (GCA) of six sunflower genotypes and specific combining ability (SCA) of their crosses as well as to estimate components of genetic variability for seed yield/plant. Genotypes were crossed according to incomplete diallel method (without reciprocals) and fifteen F1 progenies were derived. Both, additive and non-additive, genetic components were significant in seed yield expression but according to GCA/SCA ratio additive component was more important. The highest GCA value was recorded in G1 genotype, while the highest SCA value was recorded in combination G2xG3, for seed yield. Analysis of components of genetic variability revealed that dominant gene effects (H1) were more important than additive (D) and frequency of dominant genes was greater than recessive ones. Dominant and recessive genes were not equally distributed among parents as presented by the $H_2/4H_1$ ratio which was different than 0.25 (0.17). According to average degree of dominance (1.14) superdominance was the case in seed yield expression.

Key words: seed yield, combining ability, dominant and recessive genes

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops in the World and main crop for production of edible oil in Serbia. Consequently, main goals in sunflower breeding are increased seed yield and thus oil yield per hectare. Sunflower seed yield, as a complex trait, requires the most effort in breeding process because all other goals in breeding through improving individual properties are in a function of increasing seed yield and thus oil yield. The success in creating new, superior, genotypes largely depends on the possession of adequate genetic variability in the parental material because the greater are the chances for obtaining superior F1 plants. Furthermore, for successful breeding it is necessary to dispose information about mode of inheritance and combining ability. Obtained information helps in breeding process through selection of perspective parental lines with the aim of creating genotypes that will improve production. There are many papers that deal with this topic which differ in the results. Previous results have found that both, additive and non-additive, components are important in the inheritance of seed yield (Škorić et al., 2007). Some authors emphasize the larger importance of additive component of genetic variance for seed yield (Putt, 1966; Sindagi et al., 1979; Petakov, 1992 and Karasu et al., 2010). Contrary to them, larger role of non-additive component on the inheritance of seed yield was determined in previous research by many authors (Marinković, 1984; Mihaljčević, 1989; Joksimović, 1992; Lande et al., 1997; Rather et al., 1998; Goksoy et al., 2000; Cecconi et al., 2000; Jocić, 2002, 2012; Sakthivel, 2003; Farrokhi et al., 2008; Gvozdenović et al., 2008 and Hladni et al., 2010). Combining abilities are divided into general (GCA), which represent the value of the parent used in crosses, and specific (SCA), representing the value of certain crossing. The most reliable method for testing combining abilities of genotypes is diallel (Živanović et al., 2006). Diallel crossing was proposed by the zoologist-geneticist Dr. Schmidt (1919) and firstly applied in plants by Sprague and Tatum (1942). Masood et al. (2005) used 8x8 diallel to test combining ability in sunflower and

found greater importance of non-additive effects in controlling seed yield. Vice versa Mijić et al. (2008) in 6x6 diallel of sunflower inbred lines found greater significance of additive component. Investigating the GCA/SCA ratio in inbred lines of sunflower using the method line x tester Andarkhor et al. (2013) have found greater importance of non-additive genetic components in controlling seed yield, considering that GCA/SCA ratio was less than 1 (<1).

Objective of this study was to evaluate combining abilities of sunflower genotypes through their crossings and to obtain information about components of genetic variance.

MATERIAL AND METHODS

Six sunflower genotypes were crossed according to incomplete diallel (without reciprocals). F1 progeny and parents were sown in three replicates in a randomized block design at Rimski šančevi experimental field of the Institute of Field and Vegetable Crops from Novi Sad. Experimental plot size was 10 m² with four, 3.6 m long rows and 70x30 cm plant spacing. The data were recorded on 10 plants in each replicate from middle rows. Harvest was done at the stage of physiological maturity and seed yield/plant was recorded in laboratory on a technical scale with an accuracy of 0.01 g. General combining abilities (GCA) of parents and specific combining abilities (SCA) of F1 were tested according to diallel method 2 by Griffing (1956). The assumption of this method is that there are no differences in reciprocal crosses.

Mathematical model for analysis of combining abilities as follows:

$$Y_{ij} = m + g_i + g_j + s_{ij} + 1/bc \sum \sum e_{ijkl}$$

Analysis of components of genetic variance was performed according to the method suggested by Mather and Jinks (1971).

RESULTS AND DISCUSSION

Analysis of variance of combining ability for seed yield/plant showed statistically highly significant differences in the general (GCA) and specific (SCA) combining abilities between parents used in this experiment (Tab. 1). As GCA and SCA provide information for additive and non-additive gene actions considering that GCA/SCA ratio was higher than 1 it can be concluded that additive gene action played greater importance in the inheritance of seed yield/plant. In earlier studies Putt (1966) and Sindagi et al. (1979) found that general combining ability for seed yield in sunflower is more important than specific combining ability, indicating that additive component is more important than non-additive. In contrast, a significant impact of non-additive component of genetic variance in the inheritance of seed yield/plant in sunflower was observed by many authors (Marinković, 1993; Bajaj et al., 1997; Kumar et al., 1998; Chandra et al., 2011 and Andarkhor et al., 2012). The highest and statistically significant and positive GCA value was calculated for the G1 genotype so it can be concluded that this genotype represents the best general combiner for improving this trait (Tab. 2). Parental genotypes G4 and G5 also demonstrated positive GCA values but without statistical significance. In other parent genotypes were established negative GCA effects. Significant and positive value of SCA effect was recorded only in crossing combination G2xG3. In other crossing combinations SCA values were not statistically significant, while in five crossings were found negative SCA values.

Table 1. Analysis of variance of combining abilities for seed yield/plant in sunflower.

Source	Df	SS	MS	F-value
GCA	5	2718.59	543.72	11.31**
SCA	15	2664.86	177.66	3.70**
Error	40	1922.97	48.07	

Table 2. GCA (diagonal) and SCA (above diagonal) effects for seed yield/plant in sunflower

Genotypes	G1	G2	G3	G4	G5	G6
G1	13.62**	-21.39	-0.04	-1.83	-9.65	10.48
G2		-5.83	17.59*	-10.48	3.22	1.92
G3			-3.78	13.45	11.96	1.26
G4				3.81	14.29	-14.33
G5					1.61	5.52
G6						-9.43

LSD_{0.05} GCA= 7.00 LSD_{0.05} SCA= 17.16
LSD_{0.01} GCA= 9.37 LSD_{0.01} SCA= 22.96

The analysis of components of genetic variance revealed that the dominant component (H₁) was greater than the additive (D), which shows that most of the genetic variation in the inheritance of seed yield/plant makes the non-additive component (Tab. 3). According to the calculated F value dominant genes prevailed in relation to recessive ones, as confirmed by the calculated frequency of dominant (u) and recessive (v) genes. Furthermore, calculated value of the H₂/4H₁ ratio indicated the unequal representation of dominant and recessive genes in parents. From the K_D/K_R ratio, which is greater than one, is also evident that the dominant genes prevailed in respect to the recessive ones, in the inheritance of seed yield/plant. Average degree of dominance $\sqrt{H_1/D}$ (1.14) indicated that superdominance was the case in expression of seed yield/plant, considering all crossings.

Table 3. Components of genetic variance for seed yield in sunflower.

Components	Value
D	535.98
H ₁	698.17
H ₂	473.63
F	544.60
E	48.07
u	0.78
v	0.22
H ₂ /4H ₁	0.17
$\sqrt{H_1/D}$	1.14
K _D /K _R	2.60

CONCLUSIONS

Main objective in breeding program is development of superior synthetics or hybrids. To achieve this aim it requires estimation of gene action in various traits in order to design an efficient breeding plan for further genetic improvement of the initial material. Sunflower seed yield is one of the most important traits considering this crop and information about combining abilities and components of genetic variance are necessary for improving this valuable trait. In this research we found that both, additive and non-additive, genetic components were important in expression of seed yield/plant but additive genetic component prevailed. According to GCA value genotype G1 is the best general combiner for improving this trait and that genotype will be used in further hybrid combinations in order to obtain highly productive hybrids of sunflower. Crossing combination G2xG3 had the highest and significant SCA value and that combination will be tested with other

perspective hybrid combinations. Analysis of components of genetic variance revealed that dominant genes were prevalent in expression of seed yield/plant, as confirmed by the frequency of dominant genes. Dominant and recessive genes were not equally distributed among parents as presented by the $H_2/4H_1$ ratio which was different than 0.25 (0.17). According to average degree of dominance (1.14) superdominance was the case in seed yield expression.

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