19TH INTERNATIONAL SUNFLOWER CONFERENCE

TRAKYA ÜNİVERSİTESİ 1982

ISC 2016

29 MAY – 3 JUNE, 2016

EDIRNE, TURKEY

ISC 2016

PROCEEEDINGS
OF
19TH INTERNATIONAL SUNFLOWER CONFERENCE

29 MAY – 3 JUNE, 2016

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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. Janet KNODEL	North Dakota State Univ.	USA	Sunflower Insects

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SESSIONS	SPEAKER
Breeding	Dr Branislav DOZET (Hungary)
Molecular Breeding	Dr. Lili QI (USA)
Agronomy and Seed Production	Dr Philippe DEBAEKE (France)
Genetic Resources	Dr Laura MAREK (USA)
Disease & Pest resistance and Management	Prof Dr Steven MASIREVIC (Serbia)
Orobanche Resistance and Management	Dr Maria JOITA-PACUREANU (Romania)
Abiotic Stress Tolerance and Management	Dr Nicolas LANGLADE (France)
Herbicide Resistance and Management	Dr Goran MALIDZA (Serbia)
Confectionery	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 & Associes,	FRANCE
Dr Leanordo VELASCO	CSIC, Cordoba,	SPAIN

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19TH INTERNATIONAL SUNFLOWER CONFERENCE
29 MAY – 3 JUNE, 2016
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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 Certficates 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 Qİ "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)	**(2nd Floor Senate Meeting Room)**	**(2nd Floor Left Meeting Room)**	**(2nd Floor Right Meeting Room)**
30.05.2016 MONDAY		**30.05.2016 MONDAY**	**30.05.2016 MONDAY**	**30.05.2016 MONDAY**
13^{30} -15^{30}	***1st Session Chair: CARLOS FEOLI***	***1st Session Chair: DR MARIA JOITA- PACUREANU***	***1stSession Chair:DR VALENTINA ENCHEVA***	***1stSession Chair: DR RENATE HORN***
13^{30} -13^{50}	***Invited Speaker*** **DR BRANISLAV DOZET** Contemporary Challenges in Sunflower Breeding	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, GOVİNDAPPA 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}		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 (*Helianthus annuus* L.) under rainfed conditions – I. DEMIR	Principal Component Analysis for Carbon Isotope Discrimination-Related Traits in Recombinant Inbred Lines of Sunflower – A. L. ADIREDJO, T. LAMAZE, P. GRIEU
14^{10} -14^{30}	Genetic analysis of seed yield related traits under optimum and limited irrigation in sunflower – M. GHAFFARI	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 (Helianthus annuus 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., KEPHALİACOS C., PIQUEMAL J., PINOCHET X.,	Exploring drought tolerance related traits in *Helianthus argophyllus*, *Helianthus annuus* 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 Compenents of confectionery sunflower (*Helianthus annuus* L.) genotype (Alaca) Under Ankara conditions – S. DAY, O. KOLSARICI	Comparative assessment of androgenic response in sunflower (*Helianthus annus*) – N. AKGUL, E. ÇABUK ŞAHIN, Y. AYDIN, A. ALTINKUT UNCUOGLU, G. EVCI, A GÜREL

	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** Sunflower diseases research progress and management	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. ȘESTACOVA, 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		Bioactivity and Phytochemical Evaluation of Sunflower (*Helianthus annuus* L.) Leaf Extract – Y. BIBI, A. QAYYUM, S. NISA	Recent Molecular Studies on Downy Mildew Disease – A. K. TURKMEN, S. CALISKAN
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 (*H. annuus* L.) – S. SUZER, E. CULHACI	Molecular Studies involved in sunflower responses in drought stres - 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 *Helianthus anomalus* and *deserticola* sunflower from the desert southwest USA – G. SEILER, L. MAREK	Isolation and identification of pathogen of Sunflower *Fusarium* Wilt - JING G. YUAN YUAN Z., GUİ Z., JİAN Z., KAİ W., JUN Z.	***Invited Speaker*** **DR PHILIPPE DEBAEKE** Sunflower and climate change in Europe: crop vulnerability, adaptation, and mitigation potential	Proteomic response of sunflower to drought stres – M. GHAFFARI, M. TOORCHI, M. VALIZADEH
09^{50} -10^{10}	The b1 locus that controls apical shoot branching in *H. annuus* 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 *Plasmopara halstedii* pathotypes in Hungary – R. BÁN, A. KOVÁCS, G. BAGLYAS, M. PERCZEL, G. TUROCZI, K. KOROSI		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 (*Orobanche cumana*) 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 (*Helianthus annuus* 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. BESSAİ, 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 (*Helianthus annuus* L.) – V. KULKARNI, SHANKERGOUD I., SUPRIYA S.M, SURESHA P.G.	PCR combined with GFP tagged *Verticillium dahliae* confirmed the seeds transmission of Sunflower *Verticillium* 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 *Helianthus annuus* and *Orobanche cumana* genomes
11^{40}-12^{00}	Optimization of Agrobacterium-mediated gene transfer systems in Turkish sunflower (*Helianthus annuus* L.) varieties – I. I. ÖZYİĞİT, S. KARADENIZ, H. TOMBULOGLU, E. FILIZ	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. ATLIG	
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 *Plasmospora* Resistance Management in Sunflower – F. BRANDL	Comparison of cytoplasmic male sterility based on PET1 and PET2 cytoplasm in sunflower (*Helianthus annuus* 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 (*Orobanche cumana* Wallr.) - Update on racial	Cadmium-potassium interrelationships in sunflower (*Helianthus annuus* 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 (*Helianthus annuus* 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 (*Helianthus annuus* 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 *Orobanche cumana* 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 *chlorophyll*-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 (*Nysius simulans* 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 (*Orobanche cumana* Wallr.) In infested areas – O. GÜNDÜZ, A. T. GOKSOY	The effect of climate factors and climate change on the yield of sunflower (*Helianthus annuus* 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** Integrated weed management in sunflower: Challenges and opportunities	Effects of Naphthalene Acetic Acid and N6-Benzyladenine on Androgenesis in *Helianthus annuus* L. Anthers - S. DAYAN, H. ARDA	Microbial Dressing of Sunflower Seeds with *Trichoderma harzianum* KUEN 1585 – Y. S. YONSEL, M. SEVİM	QTL mapping for broomrape (*Orobanche cumana* Wallr.) resistance in sunflower – I. CELİK, D. ZARARSIZ, A. FRARY, S. DOGANLAR
15^{50} -16^{10}		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 *Diaporthe / Phomopsis* species with a range of virulences on sunflower, soybeans,	Determination the genetic characterization of different lines of sunflower (*Helianthus annuus* l.)by using genetic resources

		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
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16[45]-18 [00]	***Poster Session***	***Poster Session***	***Poster Session***	***Poster Session***
19 [30] -	**Dinner Party**	**Dinner Party**	**Dinner Party**	**Dinner Party**

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09 [50]-10[10]	New virulences of *Orobanche cumana* 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 *Orobanche cumana* - 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	

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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** Sunflower Genetic Resources	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
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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** Present status and future prospects of global confectionery sunflower production	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
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CONTENTS

EFFECT OF BIOSTIMULATORS ON SEED QUALITY, YIELD AND OIL CONTENT IN SUNFLOWER

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ABSTRACT

The effect of five biostimulators on seed quality, yield and oil content in sunflower was tested in this study. Seed was treated with biostimulators Amalgerol, Slavol, Иммуноцитофит,ТАБ, Raykat Start and НИКФАН, ж, as well as with fungicide Apron XL 350 ES and insecticide Cruiser 350 FS with added polymer Sepiret. Seed treatment with particular biostimulators had significant effect on the germination energy and germination. This effect was especially visible in the second trial year, when seeds lost their germination due to a long storage period. Treatments with pure Slavol and НИКФАН, ж showed the most significant positive effect. Positive effect was completely reduced when fungicide and insecticide were used with biostimulators. The largest average seed yield was achieved in treatment with НИКФАН,ж+insecticide and fungicide (4467 kg/ha), while the highest average oil content was achieved in treatment with pure НИКФАН,ж (53.34%). However, the effect of all treatments on seed yield and oil content was weak.

Key words: Sunflower, Biostimulators, Germination Energy, Germination, Seed Yield, Oil Content

INTRODUCTION

The most important target of sunflower production is high seed yield and high oil yield. In order to achieve this, it is necessary to grow high-yielding hybrids using optimal cultivation practices. Apart from these standard measures, various biostimulators are more often used via seed treatment or foliar treatment, with various degrees of success. Biostimulators are substances that can enhance the immunity of cultivated crops, benefit their metabolism (Kolomaznik et al., 2012), and decrease the effects of stress. The type of the biostimulator, its application, genotype and environmental conditions all affect its performance.

Using different foliar biostimulators based on 2-(1-Naphthyl) acetic acid, naphthalene derivatives, etc., Tahsin and Kolev (2005) found significant increase of sunflower seed yield with treatment in the flowering phase, but not with treatment in the budding phase; additionally there was no significant effect on the oil content. Beltrano et al. (1994) used gibberellic acid and benzyladenine and recorded yield increase of 25% through the increase of 1000-seed weight and pollination in the middle part of the sunflower head. Using various biostimulators on different oil crops, Ghosh et al. (1991) reached yield increase of 10-40%, but it was inconsistent throughout the trial years. Foliar application of amino acids had positive effect on the head diameter and pollination in sunflower in drought conditions (Kheybari et al., 2013). With foliar application of Fertileader Gold (patented extract of sea algae with addition of nitrogen, boron and molybdenum), Glijin et al. (2013) found significant increase in plant height and head diameter. By treating the seed with BION (active matter BTH), Buschmann and Sauerborn (2002) achieved induced resistance of sunflower to broomrape infection.

Jakienė and Liakas (2013) treated the soil with Azofit and Amalgerol and recorded significant increase in sugar beet root yield (7.26-9.67%), sugar content and sugar yield. Boteva (2014) found that fertilization with bioproducts Biofa and Amalgerol on background Biosol resulted in increased number of fruits in pepper – on average 3.1 fruits per plant. The increase of pepper yield was recorded from 6.2% (background Lumbrikal) to 16.9% (background Biosol+Amalgerol). The foliar products Amalgerol+Cereal mix, Foliar extra and KTS were the most effective for wheat grain yield, and the increase of yield compared to untreated control was 39.3%, 38.1% and 36.2%, respectively (Kostadinova et al., 2015). Šimunić et al. (2011) reported that foliar application of Amalgerol caused increased sunflower oil yield per hectare by 7.26% and soybean grain yield by 2.56%. On the other hand, under the conditions of extremely high temperatures during the growing season and severe soil drought in the region of Dobrudzha, Milev and Todorova (2014) found that foliar application of Almagerol on soybean did not have a significant positive effect neither on seed yield nor on 1000-seed weight. Treatment of growth stimulator Amalgerol premium with herbicides Goal, Raft, Wing, Pledge and Modown as tank mixtures increased the selectivity of these herbicides (Delchev, 2013).

The seed of Nadine F1 lettuce, treated with Slavol before sowing, sprung up two days earlier than the seed that was not treated at all (Kaliđerović and Mirecki, 2013). Treating sunflower seed with Slavol (indole-3-acetic acid) and Bioplant Flora (mixture of humic and fulvic acids, amino acids, macro and micro elements) Miladinov et al. (2014a) recorded increased length of sprout root (but not sprout shoot) in individual sunflower genotypes, but also found negative effects in certain treatments. Miladinov et al. (2014b) applied the same products while testing germination energy and germination, and found positive effect in certain treatments, higher on filter paper than on sterile sand.

Чухланцев (2010) reported that sunflower seed treatment with Vermikulen ŽK (3 l/t) + Иммуноцитофит, ТАБ (0.5 g/t) VDB (0.2 l/t) provided biological efficiency in the management of root white rot and fusariosis. Treatment of sunflower seed with a mixture of Иммуноцитофит and several other formulations increased yield, 1000-seed weight and number of seeds per head in sunflower (Высоцкая, 2013), as well as assimilating leaf area by 8.9-9.1% and seed yield by 320-360 kg/ha (Фирсов et al., 2010). Иммуноцитофит stimulated the mass germination of the sunflower seeds and increased their germination ability. The yield obtained from such plants (treated seeds + threefold treatment during the vegetation: in bud formation phase + two fold treatments every 15 days with addition of 0.5% Kristalon 18, 18, 18) was on average higher by 23.54% than control (Masheva et al., 2012).

Maize seed was treated with НИКФАН and germination increased by 20-40%, fresh weight yield increased by 22-32%, quality of fresh weight also increased (Маркелова et al., 2011). Петров and Шершнев (2007) found that maize seed treated with Agat – 25K and НИКФАН had better plant development and shorter growing season (by 7-8 days) and significant increase in seed yield.

Савенкова (2011) found that treatment of *Galega officinalis* seed with Raykat Start enhanced germination and root growth. Агафонов and Шабалдас (2013) reported increased yield of soybean seed treated with Raykat Start and several other products. However, this was not in agreement with Гракова (2011).

The aim of this study was to assess the effects of treating sunflower seed with biostimulators Amalgerol, Slavol, Иммуноцитофит, ТАБ, Raykat Start and НИКФАН, ж on seed yield, oil content and seed quality parameters.

MATERIAL AND METHODS

The trial was set up as split-plot design at the experimental field Rimski šančevi of the Institute of Field and Vegetable Crops in Novi Sad, Serbia in 2012 and 2013. The seed of sunflower hybrid Baća produced in 2011 was used in the trial and regular cultivation practices were performed.

The seed was treated with the systemic insecticide Cruiser 350 FS (1 l per 100 kg seed) and fungicide Apron XL 350–EC (300 ml per 100 kg seed), with addition of polymer and colorant Sepiret (300 ml per 100 kg seed), according to the regular sunflower seed processing procedure at the Institute of Field and Vegetable Crops. Additionally, the seed was treated with biostimulators in doses recommended by the manufacturers: Amalgerol at a concentration of 2%, Slavol at a concentration of 25%, Иммуноцитофит,ТАБ - one tablet in 10-15 ml of water per 5 g seed, Raykat Start - 0.5 l per 1000 kg seed, НИКФАН,ж- 0.6 l in 10 l of water per 1000 kg seed.

Amalgerol is an organic stimulator and soil enhancer. It contains essential oils, plant extracts and plant oils, marine algae extracts and mineral oil distillates. Slavol is a liquid microbiological fertilizer and growth stimulator certified for organic and traditional agricultural crop production. This product contains no chemical additives and has beneficial effect on the crops, soil and the environment. Иммуноцитофит, ТАБ is a plant growth regulator with active matter arachidonic acid ethyl ester. Raykat Start is a special fertilizer for the initial plant growth, used as seed / tuber dressing (free amino acids 4%, polysaccharides 15%, cytokine 0.05%, nitrogen (N) a single 4%, phosphorus pentoxide (P_2O_5) water-soluble 8%, potassium (K_2O) soluble in water 3%, iron (Fe) chelate EDDHA 0.1%, zinc (Zn) chelate of EDTA - 0.02%, boron (B) water-soluble 0.03%). НИКФАН, ж is an environmentally-friendly fertilizer, a product of microbiological synthesis mushroom-producing properties with strong stimulator for plant growth and development.

Oil content in clean seed was determined by nuclear magnetic resonance (NMR) method, according to Granlund and Zimmerman (1975). Sunflower seed yield was calculated to t/ha and corrected to 11% moisture. Laboratory analyses were performed in 2012 and 2013 at the Laboratory for Seed Testing of the Institute of Field and Vegetable Crops according to randomized block design in four repetitions, and the tested parameters were determined by standard laboratory methods. The data were processed in GENSTAT, and two-factorial analysis of variance was used for assessing results.

RESULTS AND DISCUSSION

The treatment of sunflower seed with the tested biostimulators did not show significant effect on the oil content in seed (Table 1). The highest oil content on average for both trial years was found in seed treated with pure НИКФАН, ж (53.34%), and the lowest in seed treated with the combination of Raykat Start with Apron and Cruiser (51.78%). Between these two treatments the differences were significant, but not highly significant, and in individual years there were no significant differences among the treatments (Table 2). No significant differences were found between the control and the treatments. In 2013 there was a higher average oil content than in 2012, but the differences were not significant.

Sunflower seed treatment with the tested biostimulators did not significantly affect the seed yield (Table 3). The highest seed yield was found in seed treated with НИКФАН, ж + Apron and Cruiser (4467 kg/ha), and the lowest in seed treated with Slavol + Apron and Cruiser (3846 kg/ha). The differences between these two treatments were significant, but not highly significant (Table 4). There were no significant differences in relation to the control, and there were no significant differences among all treatments in individual trial years. The

highest average seed yield was achieved in 2013 (4431 kg/ha), and the lowest in 2012 (3853 kg/ha), there were no significant differences between the trial years.

Table 1. ANOVA for oil content in hybrid Baća seed

Source of variation	df	SS	MS	F	P
Year of study (Y)	1	74.64	74.64	6.71	0.122^{ns}
Error Y	2	22.25	11.13	10.14	-
Treatment (T)	15	18.56	1.24	1.13	0.353^{ns}
Y x T	15	7.60	0.51	0.46	0.950^{ns}
Error T	60	65.84	1.10	-	-
Total	93	188.89	-	-	-

**significant at 1% level; *significant at 5% level; ^{ns}not significant

Table 2. Effect of year and biostimulators on oil content (%) in hybrid Baća seed

Treatments (T)	Trial year (Y)		Mean
	2012	2013	(T)
Control	53.64	51.64	52.64
Amalgerol	53.18	50.98	52.08
Amalgerol+Apron XL 350 ES	54.35	52.08	53.21
Amalgerol+Apron XL 350 ES+Cruiser 350 FS	54.50	52.11	53.30
Slavol	53.09	51.80	52.45
Slavol+Apron XL 350 ES	54.00	51.28	52.64
Slavol+Apron XL 350 ES+Cruiser 350 FS	53.61	51.63	52.62
Иммуноцитофит,ТАБ	53.70	51.72	52.71
Иммуноцитофит,ТАБ+Apron XL 350 ES	54.09	52.04	53.06
Иммуноцитофит,ТАБ+Apron XL 350 ES+Cruiser 350 FS	53.55	51.38	52.46
Raykat Start	53.27	52.17	52.72
Raykat Start+Apron XL 350 ES	53.90	52.68	53.29
Raykat Start+Apron XL 350 ES+Cruiser 350 FS	52.30	51.26	51.78
НИКФАН,ж	53.66	53.02	53.34
НИКФАН,ж+Apron XL 350 ES	53.62	51.83	52.72
НИКФАН,ж+Apron XL 350 ES+Cruiser 350 FS	52.92	51.57	52.25
Mean (Y)	53.59	51.82	

	Y	T	Y x T
$LSD_{0.05}$	2.93	1.21	2.35
$LSD_{0.01}$	6.76	1.61	3.30

Both seed treatment and trial year showed highly significant effect on the germination energy of sunflower seed (Table 5). The highest average of germination energy was found in seed treated with pure Slavol (90.62%), and the lowest in seed treated with the combination Amalgerol + Apron and Cruiser (80.12%). The differences between these two treatments were highly significant and the treatment with Slavol gave significantly higher germination energy than the control (Table 6). In 2012 there was highly significantly higher average of germination energy (91.89%) than in 2013 (78.48%). In 2012 no treatment showed significantly higher germination energy than the control, but there were several combinations with highly significant differences. Namely, highly significantly higher germination energy

was found in seed treated with НИКФАН, ж + Apron than in Raykat Start + Apron and Cruiser. In 2013 the differences among treatments were much higher – treatments with only Slavol and НИКФАН, ж were highly significantly higher or significantly higher than the control, but there were also significant reductions in some treatments, mostly in Amalgerol + Apron and Cruiser. These results imply that seed treatment with biostimulators showed more effect on the seed with lower average of germination energy, as was the case in 2013. It was discovered that in treatments with certain biostimulators which showed positive effect, the positive effect was lacking in combinations of biostimulator with fungicide and insecticide. Since seed treatment with fungicides (and insecticides as well) is a mandatory measure in seed processing, the practical possibility of biostimulator application is questionable.

Table 3. ANOVA for seed yield of hybrid Baća

Source of variation	**df**	**SS**	**MS**	**F**	**P**
Year of study (Y)	1	8015126	8015126	5.21	0.150^{ns}
Error Y	2	3076814	1538407	7.92	-
Treatment (T)	15	3328390	221893	1.14	0.341^{ns}
Y x T	15	1022172	68145	0.35	0.986^{ns}
Error T	60	11649289	194155	-	-
Total	93	39227240	-	-	-

**significant at 1% level; *significant at 5% level; ^{ns}not significant

Table 4. Effect of year and biotimulators on seed yield (kg/ha) of hybrid Baća

Treatments (T)	Trial year (Y)		Mean
	2012	2013	(T)
Control	3817	4317	4067
Amalgerol	3817	4692	4255
Amalgerol+Apron XL 350 ES	3994	4725	4360
Amalgerol+Apron XL 350 ES+Cruiser 350 FS	4053	4279	4166
Slavol	3661	4237	3949
Slavol+Apron XL 350 ES	3918	4139	4028
Slavol+Apron XL 350 ES+Cruiser 350 FS	3718	3975	3846
Иммуноцитофит,ТАБ	4013	4585	4299
Иммуноцитофит,ТАБ+Apron XL 350 ES	3764	4630	4197
Иммуноцитофит,ТАБ+Apron XL 350 ES+Cruiser 350 FS	3530	4221	3875
Raykat Start	3868	4554	4211
Raykat Start+Apron XL 350 ES	3901	4740	4320
Raykat Start+Apron XL 350 ES+Cruiser 350 FS	4081	4518	4299
НИКФАН,ж	3826	4319	4072
НИКФАН,ж+Apron XL 350 ES	3531	4186	3858
НИКФАН,ж+Apron XL 350 ES+Cruiser 350 FS	4156	4778	4467
Mean (Y)	3853	4431	

	Y	T	Y x T
$LSD_{0.05}$	1089	509	918
$LSD_{0.01}$	2513	677	1270

Seed treatment and trial year showed highly significant effect on the seed germination (Table 7). The highest mean seed germination was achieved in seed treated with pure Slavol

(91.12%), and the lowest in seed treated with Amalgerol + Apron and Cruiser (81.12%). The difference was highly significant and the treatment with Slavol showed significantly higher germination than the control (Table 8). In 2012 mean seed germination (93.03%) was highly significantly higher than in 2013 (79.80%). In individual years, the trends were similar to the germination energy, i.e. the treatment was more effective in a year with lower mean germination. In 2012 no treatment showed significant difference in relation to the control, but there were highly significant differences among individual treatments. In 2013 the treatments with Slavol and НИКФАН, ж showed highly significant increase in seed germination than the control. In 2013 the treatment with pure biostimulators showed better results than the treatments with added fungicides and insecticides, while in 2012 this was not the case.

Table 5. ANOVA for the germination energy of hybrid Baća seed

Source of variation	df	SS	MS	F	P
Year of study (Y)	1	5751.28	5751.28	446.68	<.001**
Error Y	15	1016.50	67.77	5.26	<.001**
Treatment (T)	15	675.72	45.05	3.50	<.001**
Y x T	93	1197.44	12.88	-	-
Total	124	8855.50	-	-	-

**significant at 1% level; *significant at 5% level; nsnot significant

Table 6. Effect of year and biostimulators on the germination energy (%) of hybrid Baća seed

Treatments (T)	Trial year (Y)		Mean
	2012	2013	(T)
Control	93.75	80.00	86.88
Amalgerol	90.75	79.25	85.00
Amalgerol+Apron XL 350 ES	94.25	79.25	86.75
Amalgerol+Apron XL 350 ES+Cruiser 350 FS	90.75	69.50	80.12
Slavol	92.75	88.50	90.62
Slavol+Apron XL 350 ES	90.25	73.25	81.75
Slavol+Apron XL 350 ES+Cruiser 350 FS	90.00	74.25	82.12
Иммуноцитофит,ТАБ	91.75	85.00	88.38
Иммуноцитофит,ТАБ+Apron XL 350 ES	91.50	78.50	85.00
Иммуноцитофит,ТАБ+Apron XL 350 ES+Cruiser 350 FS	94.00	76.50	85.25
Raykat Start	91.75	78.50	85.12
Raykat Start+Apron XL 350 ES	92.25	77.25	84.75
Raykat Start+Apron XL 350 ES+Cruiser 350 FS	88.50	76.75	82.62
НИКФАН,ж	91.50	86.75	89.12
НИКФАН,ж+Apron XL 350 ES	95.50	79.00	87.25
НИКФАН,ж+Apron XL 350 ES+Cruiser 350 FS	91.00	73.50	82.25
Mean (Y)	91.89	78.48	

	Y	T	Y x T
$LSD_{0.05}$	1.26	3.56	5.04
$LSD_{0.01}$	1.67	4.72	6.67

It is evident that the sunflower seed treatment with the tested biostimulators did not generally result in a significant increase of oil content in seed and seed yield, which is contrary to the results on sunflower reported by Šimunić et al. (2011), Высоцкая (2013),

Фирсов et al. (2010), on maize by Маркелова et al. (2011), and on soybean by Агафонов and Шабалдас (2013). Lack of biostimulator effect on soybean yield was reported by Milev and Todorova (2014). There was a certain effect in individual treatments, but it was difficult to deduce any regularity which could justify commercially viable recommendations for general use.

Table 7. ANOVA for seed germination of hybrid Baća

Source of variation	df	SS	MS	F	P
Year of study (Y)	1	5604.76	5604.76	504.45	<.001**
Error Y	15	784.18	52.28	4.71	<.001**
Treatment (T)	15	702.37	46.82	4.21	<.001**
Y x T	93	1033.29	11.11	-	-
Total	124	8269.05	-	-	-

**significant at 1% level; *significant at 5% level; nsnot significant

None the less, the seed quality parameters showed different results. The effect of the treatment was much higher, especially in years with low mean values of germination and germination energy. The best effect was achieved with Slavol and НИКФАН, ж. The positive effects of individual biostimulators on the sunflower seed quality parameters were previously reported by Miladinov et al. (2014b), Masheva et al. (2012), and on other crops by Маркелова et al. (2011) and Савенкова (2011). The problem is that the combination of biostimulators with fungicides or fungicides and insecticides did not show any positive effects as pure biostimulators did, which greatly impedes the practical use of biostimulators.

Table8. Effect of year and biostimulators on seed germination (%) of hybrid Baća

Treatments (T)	Trial year (Y)		Mean
	2012	2013	(T)
Control	94.00	81.00	87.50
Amalgerol	92.00	79.50	85.75
Amalgerol+Apron XL 350 ES	95.25	79.50	87.38
Amalgerol+Apron XL 350 ES+Cruiser 350 FS	91.50	70.75	81.12
Slavol	93.75	88.50	91.12
Slavol+Apron XL 350 ES	90.75	74.25	82.50
Slavol+Apron XL 350 ES+Cruiser 350 FS	91.50	76.75	84.12
Иммуноцитофит,ТАБ	92.75	85.25	89.00
Иммуноцитофит,ТАБ+Apron XL 350 ES	93.50	79.00	86.25
Иммуноцитофит,ТАБ+Apron XL 350 ES+Cruiser 350 FS	97.50	78.00	87.75
Raykat Start	93.00	79.25	86.12
Raykat Start+Apron XL 350 ES	93.75	78.50	86.12
Raykat Start+Apron XL 350 ES+Cruiser 350 FS	89.25	82.50	85.88
НИКФАН,ж	92.00	87.50	89.75
НИКФАН,ж+Apron XL 350 ES	96.00	79.25	87.62
НИКФАН,ж+Apron XL 350 ES+Cruiser 350 FS	92.00	77.25	84.62
Mean (Y)	93.03	79.80	

	Y	T	Y x T
$LSD_{0.05}$	1.17	3.31	4.68
$LSD_{0.01}$	1.55	4.38	6.20

In the current situation of slow increase of genetic yield and quality potential in new cultivars of many crops and the level of cultivation practices that cannot easily be revolutionized nor quickly improved, various biostimulators are more often being used. The results show that the positive effects were not as spectacular as marketed or reported in different studies. Individual biostimulators certainly hold their place in the improvement of individual crops cultivation, so investments into biostimulators application must be economically viable, which is only possible through detailed and objective studies in different agricultural environments using different genotypes.

CONCLUSIONS

Sunflower seed treatment with the tested biostimulators did not show significant effect on oil content in seed nor the seed yield. The highest oil content on average for both trial years was found in seed treated with pure НИКФАН, ж (53.34%), and the lowest in seed treated with Raykat Start in combination with Apron and Cruiser (51.78%). Between these two treatments the differences were significant, but not highly significant, and in individual years there were no differences between the treatments. The highest seed yield was found in seed treated with НИКФАН, ж + Apron and Cruiser (4467 kg/ha), and the lowest in seed treated with Slavol + Apron and Cruiser (3846 kg/ha). The differences between these two treatments were significant, but not highly significant.

Sunflower seed treatment with the tested biostimulators showed highly significant effect on the seed quality parameters. The highest mean first count was found in seed treated with pure Slavol (90.62%), and the lowest in seed treated with Amalgerol + Apron and Cruiser (80.12%). The differences between these two treatments were highly significant, and the treatment with Slavol showed significantly higher germination energy than the control. The highest mean seed germination was found in the seed treated only with Slavol (91.12%), and the lowest in seed treated with Amalgerol + Apron and Cruiser (81.12%). The difference was highly significant and treatment with Slavol showed significantly higher germination than the control.

The conclusion is that the tested biostimulators could be more applicable in seed production than in commercial (mercantile) production. Practical application of individual biostimulators for enhancement of seed quality parameters is restricted by the fact that the positive effects drastically drop when biostimulators are combined with fungicides and insecticides, which should further be studied. This indicates that biostimulators can be used more successfully in organic production.

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