SUNBIO 2010

8TH EUROPEAN SUNFLOWER BIOTECHNOLOGY CONFERENCE

1-3 MARCH 2010, ANTALYA, TURKEY

Organized By
Republic of Turkey
Ministry of Agriculture and Rural Affairs
The General Directorate of Agricultural Research
Trakya Agricultural Research Institute – Edirne

Collaboration with

Turkish Plant Breeders Association
International Sunflower Association
FAO (Food and Agriculture Organization)

MAIN ORGANIZER

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WELCOME NOTES

As organizing committee of **8th European Sunflower Biotechnology Conference,** we would like to thank you firstly for responding to our invitation to meet in Antalya, and for your scientific support through your presentations.

Our conference brings together a variety of sunflower researchers from government, commercial and academic organizations worldwide to foster cooperation on sunflower and to promote sharing information among researchers largely. Total 70 papers (30 oral and 40 posters) will be presented during the conference.

The aim of our conference is to present the newest research results and research goals to analyze present conditions and perspectives in conventional and molecular sunflower breeding, biotechnology, molecular methods and tools with enhancing our knowledge and the vision of all sunflower people. As always, we also extend a warm welcome to all our colleagues in the sunflower research and industry who share our interest in improving information to increase the income of sunflower producers.

As one of beautiful cities in the world, first time visitors to Antalya are usually charmed by the sheer beauty of the city and surroundings. Antalya is a city that manages to surprise and enthuse in equal measure, with reminders of Antalya's rich landscape and historical sites. Antalya which is Turkey's principal holiday resort is an attractive city with palm lined street and is full of history with a beautiful coastline of beach and rocky coves where the towering Toros mountains. There is sunshine for 300 days of the year in Antalya and it is perfect place for sunbathing and swimming or for sporting activities such as windsurfing water-skiing, sailing and also climbing, trekking, hunting and skiing on mountains, etc. We are sure that these days and full day sightseeing tour will be enough to notice the beauty of Antalya province but not enough to discover it.

We wish you wonderful stay and great fun in Antalya during the conference.

Dr. Yalçın KAYA
Chair
On the behalf of Organizing Committee

FOREWORD

Trakya Agricultural Research Institute (TARI) was constituted as orchard station in 1924, and then connected under in Ministry of Agriculture. TARI turned out to be research station in 1949 and became Regional Agricultural Research Institute at 25 December 1969. After 1 May 1987, it was named as Trakya Agricultural Research Institute. TARI carried out research on field crops and plant protection in Trakya region which is in European part of Turkey. Additionally, TARI got responsibility as regional coordinator on pasture and grassland management and improvement research and works in Marmara Region. TARI has been working on sunflower, rice, wheat, barley, oat, soybean, safflower, flax, canola etc. to develop new cultivars which have high quality, yielding and adaptation capability, new agronomy techniques to increase farmer income, to determine alternative crop for the region and to produce elite and certified seed for seed producers and farmers.

Although sunflower history was starting at 1960s in Turkey, the main sunflower research and breeding program in sunflower was initiated in our institute in 1970s. However, sunflower breeding program were accelerated in 1978 after starting as National Sunflower Research Program in Turkey. Then, our institute nominated also as the national coordinator institute for sunflower research in Turkey. At the beginning of 1980s, sunflower genetic materials were collected mostly via introduction and from different parts of Turkey and the world in TARI, then sunflower breeding research were speeded up as national basis including hybrid breeding year by year.

We would like to thank you to join this conference and I would like to give special thanks our sponsors; they give us big supports to organize this conference.

Dr. Necmi BEŞER
Director
Trakya Agricultural Research Institute

FOREWORD

On behalf of the Organizing Committee, we would like to welcome all participants to the 8th SUNBIO conference and we would like thank you to join our event.

As a general director of The General Directorate of Agricultural Research (GDAR), I would like to give some information about our goals and priorities. As being headquarters of national agricultural research system, development of research strategy of Turkey, determination of priorities and coordination of research programs are the main objectives of us. Currently, we are working as 58 research institutes under our supervision dealing with the whole range of agricultural issues throughout our country.

Sunflower is the main oil crop for Turkey both also in Blacksea Region countries having more than half of world sunflower areas and production. We are importing high amount of oil seeds so we want to increase our oil crops production in Turkey. Because of that, as Ministry and government policy, we apply some subsidies to increase sunflower and other oil crops. Sunflower also exists at first rank on research priorities of GDAR both in national and international level.

As the representative of Turkey in EU, I also would like to mention that starting the importance new project ideas on EU Research Framework. As existing in the conference program, if you or your organizations are interested to join taking part in preparing new projects, this will be great opportunity for further developments of sunflower research. These efforts will contribute to increase our collaboration at international level among us. As GDAR, not only in sunflower, both also in all crops, we are ready to collaborate so willingly with you.

We hope that this conference will address problems of the related countries, and we hope that a good network for collaboration can be established and a better relationship developed between all the countries represented.

Finally, we wish success for this meeting and hope a great scientific achievement with your contributions. We would like to add that we are too much pleased to host you all in Antalya, and in our country.

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

Assoc. Prof. Dr. Masum BURAK,
General Director,
The General Directorate of Agricultural Research -Turkey

PROCEEDINGS OF 8TH EUROPEAN SUNFLOWER BIOTECHNOLOGY CONFERENCE

CONFERENCE PROGRAM:

SUNDAY, FEBRUARY 28, 2010	
17 ^{00} - 18 ^{30}	**Registration**
MONDAY, MARCH 1, 2010	
8 ^{30} 9 ^{00}	**Registration**
9 ^{00} 9 ^{30}	**Opening Talks:** Dr. Yalcin KAYA, Chair, Organizing Committee Dr. Necmi BESER, Director of Trakya Agricultural Research Institute Assoc. Prof Dr. Masum BURAK, Director General, GDAR-Turkey
9 ^{30} 10^{00}	Invited speaker: Prof. Dr. Dragan Skoric RECENT ACHIEVEMENTS ON SUNFLOWER BREEDING
10^{00} 10^{30}	Invited speaker: Dr. Patrick Vincourt, TOWARDS A GENOMIC SEQUENCE FOR SUNFLOWER GENETICS AND BREEDING… NC Kane, SJ Knapp, J M Burke, P Vincourt, LH Rieseberg
10^{30} 10 ^{40}	Coffee break
	1st Section: Interspecific Hybridization and Wild Species **Session Chair : Dr. Andre BERVILLE**
10^{40} 11^{00}	THE ARGENTINE WILD *H. ANNUUS* L. GENETIC RESOURCE…. Cantamutto M, Poverene M, Presotto A, Alvarez D, Lenardon S, Rodríguez H, Sánchez J M, Fernandez MI, Giolitti F, Garayalde T, Haucke A, Bellido A, Fraysee M.
11^{00} 11^{20}	DEVELOPING *SCLEROTINIA* RESISTANT SUNFLOWER GERMPLASM UTILIZING WILD PERENNIAL *HELIANTHUS* SPECIES….Z. Liu, X. Cai, G. J. Seiler, T. A. Gulya, K. Y. Rashid, C. C. Jan
11^{20} 11^{40}	THE CHARACTERIZATION OF SOME WILD SPECIES OF *HELIANTHUS* FOR SOME MORPHOLOGICAL TRAITS……. Fadul Onemli, Tahir Gucer
11^{40} 12^{00}	A COMPARATIVE STUDY OF INVASIVE *HELIANTHUS ANNUUS* POPULATIONS IN THEIR NATURAL HABITATS OF ARGENTINA AND SPAIN…. Poverene M., Cantamutto M.
12^{00} 12^{20}	SELF-FERTILIZATION AND RESTORATION TO CYTOPLASMIC MALE STERILITY OF SOME WILD SPECIES OF HELIANTHUS….F. Onemli, T. Gucer
12^{20} 12^{30}	Questions and Answers
12^{30} 13^{30}	Lunch
13^{30} 16^{00}	**1th Session: Genetic Engineering, Genomics,** **Session Chair : Dr. Dragana MILADINOVIC**
13^{30} 13^{50}	CYTOPLASMIC MALE STERILITY IN SUNFLOWER – NEW CMS SOURCES, NEW INSIGHTS….S. Hamrit, U. Engelmann, U. Schnabel, A. Reddemann, M. Drumeva, R. Horn
13^{50} 14^{10}	TWO GENOMIC BASED APPROACHES TOWARDS A BETTER SUSTAINABILITY TO SUNFLOWER *HELIANTHUS ANNUUS* RESISTANCE TO DOWNY MILDEW *PLASMOPARA HASLTEDII.* Assadi F, Pouilly N, Boniface MC, Bordat A, Bellec A, Helmstetter N, Vautrin S, Berges H, Tourvieille LD, Vear F, Brunel D, Le Paslier MC, Gouzy J, Carrere S, Hourlier T, Vincourt P, Godiard L.

14^{30} 16^{00}	LOOKING FOR SUNFLOWER *HELIANTHUS ANNUUS* GENES INVOLVED IN RESPONSE TO DROUGHT STRESS: WHAT CAN WE LEARN FROM EXPRESSION DATA IN USING THE 2.6 MILLION-FEATURE AFFYMETRIX® CHIP…. Rengel D, Aribat S, Balzergue S, Martin ML, Gouzy J, Carrere S, Hourlier T, Vincourt P, Langlade N.
14^{10} 14^{20}	Questions and Answers
14^{20} 14^{40}	Coffee Break
14^{40} 17^{30}	**3rd Section: Molecular Breeding** **Session Chair : Prof. Dr. Renate HORN**
14^{40} 15^{00}	MAPPING INTROGRESSION FROM HELIANTHUS MOLLIS LAM. INTO SUNFLOWER (H. ANNUUS L.) CROP AND NEW COMPACT CROP ARCHITECTURE….Catherine Breton, Hervé Serieys, André Bervillé
15^{00} 15^{20}	GENETIC DISTANCE AND HETEROSIS FOR YIELD COMPONENTS IN HYBRID COMBINATIONS OF INBRED LINES FROM INTERSPECIES CROSSES.... D. Saftić Panković, N. Hladni, Z. Satovic, N. Radovanović, M. K. Balalić
15^{20} 15^{40}	INFLUENCES OF GENOTYPE AND EXPLANT ON CALLUS INDUCTION AND SHOOT REGENERATION IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)….. Melek Bayraktaroğlu, Nazan Dağüstü
15^{40} 16^{00}	REGENERATION OF FERTILE PLANTS FROM SUNFLOWER (*H. ANNUUS* L.) – IMMATURE EMBRYO….N Dagustu, M. Sincik, G. Bayram, M. Bayraktaroglu
16^{00} 16^{20}	BIOLOGICAL CONTROL OF SUNFLOWER DAMPING-OFF AND CHARCOAL ROT DISEASES…. Amer Mahmoud, Yalçın KAYA, Hikmet Budak
17^{00} 17^{20}	Questions and Answers
18^{30} 20^{00}	Dinner
TUESDAY, MARCH 2, 2010	
09^{00} 11^{30}	**4th Session: Conventional Breeding** **Session Chair : Prof. Dr. Enver ESENDAL**
09^{00} 09^{20}	NON-GMO IMIDAZOLINONE HERBICIDES-TOLERANT SUNFLOWER GENOTYPES, OBTAINED AT NARDI FUNDULEA….M. Pacureanu, D. Stanciu, M. Ciuca, E. Sava
09^{20} 09^{40}	ASSESSMENT OF GENETIC DISTANCE AS A PREDICTOR OF SUNFLOWER HYBRID PERFORMANCE……Alireza Nabipour
09^{40} 10^{00}	DEVELOPMENT AND STABILITY PERFORMANCE OF SOME SUDANESE SUNFLOWER HYBRIDS UNDER IRRIGATED CONDITIONS…..M. Y. Mohamed
10^{00} 10^{20}	THE STUDIES ON THE DETERMINATION OF THE COMBINING ABILITY OF INBREED LINES FOR HYBRID BREEDING BY USING LINE x TESTER ANALYSIS IN SUNFLOWER…Ahmet Semsettin TAN
10^{20} 10^{30}	SUNFLOWER (H. *ANUUS* L.) LANDRACES OF TURKEY, THEIR COLLECTIONS CONSERVATION AND MORFOMETRIC CHARACTERIZATION….A. S. Tan A.Tan
10^{30} 10^{50}	Coffee break
10^{50} 11^{10}	SUNFLOWER (*HELIANTHUS ANNUUS* L.) RESEARCHES IN AEGEAN REGION OF TURKEY…. Ahmet Semsettin TAN
11^{10} 11^{30}	THE CURRENT SITUATION OF BROOMRAPE PROBLEM IN SUNFLOWER

	PRODUCTION, THE SOLUTIONS AND FUTURE DIRECTIONS IN TURKEY…… Y. Kaya, G. Evci, V. Pekcan, T. Gucer, M. I. Yilmaz
11^{30} 11^{40}	Questions and Answers
11^{30} 16^{30}	**5th Session: Crop Production (Management, Physiology, Weeds, Seed and Oil Quality) Session Chair: Dr Brady VICK**
11^{40} 12^{00}	RESIDUAL EFFECTS OF SPRAYING *IMIDAZOLINONE* FAMILY HERBICIDES ON CLEARFIELD® SUNFLOWER PRODUCTION IN TERMS OF CROP ROTATION…. S. SÜZER, H. BÜYÜK.
12^{20} 12^{30}	Questions and Answers
12^{30} 13^{30}	Lunch
13^{30} 13^{50}	EFFECTS OF NITROGEN AND PLANT DENSITY ON DWARF SUNFLOWER HYBRIDS….Sami SÜZER
13^{50} 14^{10}	DETERMINATION OF PHYSIOLOGICAL FACTORS LIMITING YIELD BY CHANGING SOURCE–SINK RELATIONSHIP IN SUNFLOWER…..D. E. Asli
14^{10} 14^{30}	THE DETERMINATION OF THE PERFORMANCES AND THE ADOPTION SITUATION OF SUNFLOWER CULTIVARS RESISTANT TO BROOMRAPE AT FARMER CONDITIONS IN TRAKYA REGION…. A. Semerci, Y. Kaya, I. Şahin, N. Citak
14^{30} 14^{50}	THE DETERMINATION OF ADAPTATION CAPABILITIES OF SOME OIL TYPE SUNFLOWER (HELIANTHUS ANNUUS L.) HYBRIDS IN KAHRAMANMARAS CONDITIONS…..A. Çil, A. N. Çil, Y. KAYA F. KILLI
14^{50} 15^{10}	IDENTIFICATION OF RUST (Puccinia helianthi Schw.) RACES OF SUNFLOWER (*HELANTHUS ANNUUS* L.) IN TURKEY….A. S. TAN
15^{10} 15^{30}	PERFORMANCE OF SOME OILSEED AND CONFECTIONARY TYPE SUNFLOWER (*H. ANNUUS* L.) VARIETIES IN AEGEAN REGION OF TURKEY…. A. S. TAN
15^{30} 15^{50}	RESPONSE TO DROUGHT OF SOME WILD SPECIES OF *HELIANTHUS* AT SEEDLING GROWTH STAGE……. Fadul Onemli, Tahir Gucer
15^{50} 16^{10}	Questions and Answers
16^{10} 16^{30}	Coffee break
16^{30} 17^{30}	**Discussion Session**:**Project Opportunities in Sunflower on FP Framework Session Chair : Prof. Dr. Dragan Skoric**
17^{30}	Closing the symposium
18^{30} 21^{30}	CONFERENCE GALA DINNER
WEDNESDAY, MARCH 3, 2010 SIGHTSEEING TOUR (ANTALYA CITY AND AROUND)	
08^{00} 12^{30}	Visit Side Antique Theater, Aspendos Antique Theater, Manavgat and Kursunlu Waterfall
12^{00} 13^{00}	Lunch at hotel
13^{00} 19^{00}	Yatch Tour (2-3 hours with seeing Karpuzkaldıran Waterfall by sea side) Visit Antalya Kaleici and Shopping, City Tour.
19^{30} 20^{30}	Dinner
THURSDAY, MARCH 4, 2010, Leaving from the hotel	

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Dr Vehbi ESER	Honorary President
Dr Necmi BEŞER	Honorary President
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Prof Dr Renate HORN	Member
Dr Sinisa JOCIC	Member
Dr. Dragana MILADINOVIC	Member
Prof Dr Dejana PANKOVIC	Member

The hotel and sightseeing tour arrangements are organized by SSC Tour Travel Agency.
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PLENARY SESSION

INTERSPECIFIC HYBRIDIZATION AND WILD SPECIES

GENETIC ENGINEERING, GENOMICS

MOLECULAR BREEDING

CONVENTIONAL BREEDING

CROP PRODUCTION (MANAGEMENT, PHYSIOLOGY, WEEDS, SEED AND OIL QUALITY)

POSTER SESSION

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PART I: INTERSPECIFIC HYBRIDIZATION AND WILD SPECIES

THE CHARACTERIZATION OF SOME WILD SPECIES OF *HELIANTHUS* FOR SOME MORPHOLOGICAL TRAITS

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This present investigation has been undertaken to determine some plant characters on six wild *Helianthus* genotypes. *Helianthus petiolaris spp. petiolaris* (E-142), *Helianthus neglectus* (E-017) and four wild *Helianthus annuus* (E-060, E-173, E-174 ve E-175) were used as material. Observed morphological characters were plant height, head diameter, branch number, days to 50 % flowering, flowering period length and presence of anthocyanin in cotyledons. The results showed that plant height, head diameter and number of branches for these wild genotypes ranged between 63-171 cm, 2.4-8 cm and 43-324.3, respectively. The genotypes needed 82-105 days after sowing to 50 % flowering while they had 67-92 days for flowering period.

Key words: *Helianthus, H. petiolaris, H. neglectus, H. annuus*, morphology.

SELF-FERTILIZATION AND RESTORATION OF CYTOPLASMIC MALE STERILITY IN SOME WILD SPECIES OF *HELIANTHUS*

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The objectives of this study were to determine self-fertility and restoration capability of some wild sunflower genotypes. The evaluated genotypes were *Helianthus petiolaris spp. petiolaris* (E-142), *Helianthus neglectus* (E-017) and four *Helianthus annuus* (E-060, E-173, E-174 ve E-175). For hybridizations, 2453-A was used as female inbred line. Results showed that self fertility ratios of wild sunflower genotypes ranged between 22.4 and 66.1%. The highest self fertility was observed in *Helianthus petiolaris spp. petiolaris* (E-142), while *Helianthus neglectus* had the lowest values. It was observed that the species E-060 and E-174 did not restore cytoplasmic male sterility in the hybrids being tested.

Key words: *Helianthus, H. petiolaris, H. neglectus, H. annuus*, self-fertility, male sterility.

GENETIC DIVERSITY OF THE CMS-*RF* SYSTEM IN SUNFLOWER

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More than 500 sunflower genotypes representing VIR World Collection were characterized using molecular markers associated with the CMS-*Rf* genetic system. For molecular screening we applied the SCAR-markers of the *Rf1* gene involved in pollen fertility restoration of male sterile (CMS PET1) forms, and the STS-marker specific to aberrant mitochondrial gene *orfH522* responsible for CMS PET1. A strong homology of nucleotide sequences of the amplified SCAR-fragment HRG02 in different cultivated sunflower lines and the identity of the priming sites in annual (*H. annuus*) and perennial (*H. giganteus*) species were found. This confirmed a possibility for application of the SCAR-marker for large scale screening of sunflower gene pool and for revealing of the *Rf1* gene introgressions into *H. annuus* genome in interspecific hybrid progenies. Using this approach the presence of the *Rf1* gene in the genomes of perennial and annual *Helianthus* species was demonstrated and its introgressions into genomes of interspecific hybrids were proven. A differentiation of 76 inbred lines of cultivated sunflower was possible by the presence of the nuclear gene *Rf1* and type of mitochondrial DNA. The results of comparing the classical genetic and molecular data suggest that the *Rf1* gene is expressed only on the background of the aberrant mitochondrial gene *orfH522* and does not suppress another CMS (RIG0) phenotype. Firstly, we demonstrated using molecular markers that many restorer (*Rf1*) lines in VIR Collection possess CMS PET1 due to their origin from commercial hybrids. In order to avoid negative consequences of unification of the CMS it is necessary to use new sources of the fertility restoration genes for example variety populations. The presence of the *Rf1* gene was confirmed for 10 out of 11 populations of modern and ancient Russian varieties examined. Using methods of bioinformatics, PCR with specific primers, molecular cloning and sequencing the genomic fragments homologous to the known *Rf* genes (*Petunia* × *hybrida*) were characterized. They belong to the PPR-genes class participating in biogenesis of organelles and contain conserved repeats of 35 amino acids (*pentatricopeptide repeats*). Their intron/exon structure and positions of conserved PPR-motifs were determined, a polymorphism between the genotypes of *H. annuus*, *H. argophyllus* and *H. mollis* was characterized, and significant differences between the genotypes homozygous for the dominant (*Rf1*) and recessive (*rf1*) alleles of the gene were demonstrated.

This work was supported by Russian Foundation for Basic Research (08-04-90112) and Moldavian Academy of Sciences (08.820.04.19RF).

A COMPARATIVE STUDY OF INVASIVE *HELIANTHUS ANNUUS* POPULATIONS IN THEIR NATURAL HABITATS OF ARGENTINA AND SPAIN

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Wild *Helianthus annuus* is native to North America but it is found in other parts of the world as well. The origin of exotic populations is uncertain, and probably they have evolved very differently in different countries. The goal of this work was to examine and compare invasive populations from Argentina and Spain, in an attempt to unravel their origin. Morphological and agro-ecological data were collected in their natural habitats during three exploration trips in 2007 and 2008. Study materials from both countries were represented by nine populations from central Argentina and seven from Spain, including six from Andalusia and one from Gerona. In Argentina, the wild *H. annuus* was found mainly on disturbed areas between roads and fences. In a few cases the populations invaded crop lands, however, they were located in the margins of the cultivated fields. Argentine populations reached more than 50,000 m^2 and a density of about 25 plants m^{-2}. In Spain, the populations were found in croplands. Only one small population was found in a non-tilled area, near an olive plantation. The largest population was about 1,500 m^2 and comprised no more than 200 plants. Plants were screened for 24 morphological traits. Argentinean populations showed taller plants with higher number of heads of small size, while Spanish populations characterized by tougher stems, bigger heads with wider ligules and bracts. Plants were smaller and leaf size was larger in Gerona than in Andalusia. Discriminate analysis differentiated populations from Argentina and Spain by leaf shape, branching, plant height, head size and color. Moreover, there was a good differentiation among Argentinean populations, while populations from Andalusia were similar. Gene flow from wild and domestic sunflower to weedy populations is likely the source of genetic variation among them. In Argentina, wild *H. annuus* was introduced with agronomic purposes, and probably it escaped from cultivation and spread. Despite of intense gene flow within sunflower crop, populations seem to keep much more wild appearance than Spanish populations. According to previous studies, the origin of European populations probably was pollen contamination of commercial seed with wild seeds or crop-wild hybrids. Our morphological and agro-ecological data seem to confirm such hypothesis.

THE ARGENTINE WILD *HELIANTHUS ANNUUS* L. GENETIC RESOURCE

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Wild *H. annuus* from Argentina provides resistant genes for *Puccinia heliantii* tolerant sunflower varieties released by the middle of the past century. Naturalized wild populations currently located between S 32.0° to S 37.2° latitude could be a valuable genetic resource to sunflower crop. To test this hypothesis, five wild populations were selected to represent different original environments in a common garden study. Their plants showed normal chromosome behavior at diakinesis. Two of those populations normally fertilized (>70%) the CMS PET1 A10 inbred line when pollen was applied daily. Fruit set was reduced (<30%) with one accession, collected in the more humid environment when pollen was applied at a 3-day frequency. Another one, collected in the driest environment, showed high fruit set (>60%) non differences with DK4000 at 3-day pollination interval. All wild populations restored more than 80% fertility of CMS PET1 HA89 and CMS PET1 A10 inbred lines at F1 generation, but none of them restored the CMS RES1 HA89, with *H. resinosus* cytoplasm. The fertility of a male sterile source from Las Malvinas population was partially restored (66%) by RHA274 line, but the restorers RPET2, R49, R432 and R307 failed to produce more than 10% of fertile progenies at F1 generation. Male fertility restoration over 95% was obtained using maintainer line B10 pollen. The fatty acid content differentiated one population from Entre Ríos, with saturated fatty acid over 107 g kg^{-1}. Another population from La Pampa, with probable introgression of *H. petiolaris*, showed high level (> 50%) of resistance to Sunflower chlorotic mottle virus (SuCMoV). The five wild populations did not show tolerance to imazaphyr sprayed at 4-6 leaf stage at 2X doses (160g ha^{-1}). The population collected in the southern and coolest point of the geographic distribution of wild sunflowers, showed high tolerance to low temperature (15/5°C, neutral day) at initial stages (<3 expanded leaves). Eleven morpho-physiological traits differenced the wild populations in their response to water stress. A population from Córdoba province, collected in a dry habitat, with an overall good performance to drought, showed higher germination (>80%) under water stress (-0.4 MPa) imposed by polyethylen glycol 6000. This population and another from southern Buenos Aires showed the lowest leaf temperature increase (<10%) and the highest foliar specific density under water stress (irrigation covering 50% of potential air demand) during R4 to R6 stages. It could be concluded that wild *H. annuus* naturalized in central Argentina can supply some useful traits for sunflower breeding.

DEVELOPING *SCLEROTINIA* RESISTANT SUNFLOWER GERMPLASM UTILIZING WILD PERENNIAL *HELIANTHUS* SPECIES

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Cultivated sunflower lacks a sufficient level of resistance to both *Sclerotinia* stalk and head rot, but abundant resistance in perennial *Helianthus* species has been confirmed. The project objectives were to transfer *Sclerotinia* resistant genes from wild perennial hexaploid, diploid *Helianthus* accessions and interspecific amphiploids into cultivated sunflower. Interspecific F_1 hybrids were produced between resistant hexaploid *H*. *californicus* and *H*. *schweinitzii* and cultivated inbred line HA 410 with continued backcrossing of *H. californicus* crosses with HA 410 and selfing in BC_4F_3 plants improved pollen and seed fertility between 2n=34 and 37 in 2008. Further backcrossing and selfing in 2008 increased seed in 2009. Five highly resistant amphiploids were crossed with HA 410 in 2006, and BC_2F_2 /BC_3F_1 plants from 2n=34 to 36 were obtained in the greenhouse in 2008, and backcrossed and selfed to produce seed for 2009 field evaluation. Crosses between NMS HA89 and head rot resistant *H. maximiliani* and *H. nuttallii* were backcrossed with cultivated inbred line HA 441 and advanced to BC_1F_3 and BC_2F_3 generation in 2008 and 2009 for seed increase. In 2007, resistant diploid perennial *H. maximiliani, H. giganteus,* and *H. grosseserratus* were crossed with HA 410 and their BC_1F_2 /BC_2F_1 progenies with 2n=34 to 35 chromosomes were obtained in 2008. Their selfed BC_1F_3 and BC_2F_2 progeny were grown in the field in 2009 for seed increase. Replicated field tests with 163 and 313 progeny families were screened for resistance in 2009, respectively. The results indicated moderate to good resistance, suggesting successful gene introgression. Molecular tracking studies using SSR markers indicated high polymorphism between wild resistant donors and the cultivated recurrent parents, and the retention of markers specific to resistant donors was higher for progenies from diploid perennials than from hexpaloid or interspecific amphiploids, suggesting a higher frequency of gene introgression when perennial diploids species were used. Identified resistant lines will retest in 2010 and the results will be used to release germplasm, providing new resistance genes to enhance *Sclerotinia* resistance in sunflower. Selected lines will be used to develop QTL mapping with the ultimate goal of identifying major QTLs to use in future MAS. New crosses on other resistant sources of hexaploid and diploid perennial *Helianthus* accessions with cultivated sunflower will be initiated in 2010. Protocol of genomic *in situ* hybridization (GISH) distinguishing chromosomes of perennial *Helianthus* species and cultivated sunflower providing an additional tool for studying gene transfer.

SUNFLOWER PHOMOPSIS LESION OF WILD PLANTS

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Diaporthe/Phomopsis helianthi is the sunflower Phomopsis pathogen, first registered in Yugoslavia in 1960, where mass early plant drying occurred. One of the most widespread hypotheses is that the pathogen can be transmitted to sunflower from weeds of *Compositae* family. Some authors identified both species *Diaporthe/Phomopsis* on *Xanthium italicum*. Before that, only sunflower was known as a host plant for *D. helianthi*. Using morphological, cultivating methods and phylogenetic analysis of a nuclear ribosomal DNA, it was determined that *X. italicum* was a new host plant for *D. helianthi*. In Krasnodar Region (Russia) *D./Ph. helianthi* was found on *X. strumarium L*., *Cyclachena xanthifolia natt. Frezen., Lappa minor Hill., Abutilon teophrasti Med.* and *Sonchus asper (L.) vill*. As well, it was shown that the Phomopsis pathogen affecting wild plants had more intensive pathologic process, the fungus extended fast in stems, in head parenchyma causing seed lesion and then plant losses within 20-30 days. The target of the research was to continue the detection of wild plants affected by the sunflower Phomopsis pathogen. In the period of 2005 – 2008 wild plants with lesion symptoms similar to sunflower Phomopsis signs, were detected and tested for *D.*/*Ph. helianthi* using morphological and cultural methods. Sunflower plants were inoculated with the detected fungi of the mentioned family by means of mycelium injection into leafstalk cut. It was determined that the symptoms similar to Phomopsis lesion signs can be found both on plants growing in surroundings (adjusting area) and on sunflower crops. Meanwhile, they are caused by different Phomopsis *и* Diaporthe fungi family species. The fungi pycnidium and pyrenocarp size and shape are various. Pyrenocarps can have the shape similar to pycnidia, and pycnidia can be with rostrums like pyrenocarps. The fungi species composition altered depending on the year. *D.*/*Ph. arctii* was found on Inula helenium samples selected in 2005, D./ Ph helianthi - in 2006, D. sp.- in 2008. Pycnidia were also found on *Cichorium intybus* stems in moist chamber; their content was not identified for a long time under climatic chamber conditions. Bigger pycnospores (conidia) than those of *Ph. helianthi*, appeared in pycnidia only by daylight, and they were septate. The fungus was referred to Ph. sp. The detected fungi species infected injured (cut) sunflower. On *Erigeron annuus* stems under moist chamber conditions only rounded pyrenocarps without rostrums were found but they contained typical D. sp. ascospores. Thus, different fungi species of Phomopsis *и* Diaporthe families were found on weeds in central zone of Krasnodar Region in 2005 – 2008. And the species causing sunflower Phomopsis were discovered on *Inula helenium* L. for the first time.

The research is supported by ISTC Project #3034.

INTEGRATED APPROACHES FOR INTROGRESSION OF RESISTANCE TO *ALTERNARIA HELIANTHI* AND SUNFLOWER NECROSIS DISEASE

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Sunflower production in India is constrained by the vulnerability of the released varieties/hybrids to a number of biotic stresses of which *Alternaria helianthi* and sunflower necrosis disease cause economic yield losses. Sources of resistance to these two diseases are rather limited in the crop germplasm. Hence, attempts were made to identify reliable sources of resistance in wild *Helianthus* species, exotic lines, core germplasm and prebreeding lines derived through interspecific hybridization with diploid annual species. Resistance to *Alternaria* has been recorded in nine perennial species of the perennial habit group, but transfer of resistance to cultivated sunflower is constrained by ploidy differences and incompatibility barriers. Methods of *in vitro* colchiploidy and anther culture were developed to recover fertile interspecific hybrids from some of the cross combinations between cultivated sunflower with hexaploid species and diploid perennials. Owing to the lack of adequate levels of resistance in cultivar germplasm and problems associated with transfer of traits from wild species, an attempt is being made for development of transgenics sunflower resistant to necrosis disease through deployment of the TSV coat protein gene in sense and antisense orientations.

PART II: GENETIC ENGINEERING, GENOMICS

CYTOPLASMIC MALE STERILITY IN SUNFLOWER – NEW CMS SOURCES, NEW INSIGHTS

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Cytoplasmic male sterility (CMS) is a maternally inherited trait in which higher plants fail to produce or shed functional pollen. CMS is due to modifications in the mitochondrial DNA creating new chimeric open reading frames. Fertility restorer genes in the nucleus are able to restore male fertility again, which makes CMS an interesting system for hybrid production. In sunflower, more than 70 CMS sources either occurring spontaneously or induced by intra- or interspecific crosses as well as by mutagenesis have been described. Twenty-eight cytoplasmic male sterility sources were analyzed on DNA and protein level to describe CMS in sunflower. The PET1 cytoplasm, which originated from an interspecific cross of *H. petiolaris* and *H. annuus*, is so far the best described cytoplasm in sunflower due to its importance for commercial hybrid breeding. However, the use of only one CMS source carries a considerable risk for infections by pathogens. Therefore, the use of other well described, new cytoplasms like PET2, PEF1 or GIG1 is of major interest. New restorer lines were identified for these CMS-sources that allow the production of fully stable fertile hybrids. These new CMS sources are different from the PET1 cytoplasm on the level of the mitochondrial DNA as well as on protein level. Hybridizations using *atp6*, *atp9* and *cob* as probes identified restriction polymorphisms between PET2, PET1 and HA89. These fragments were cloned and sequenced. Two new open reading frames *orf288* and *orf231* could be identified which represent possible candidate genes for the CMS cause. Both *orfs* are transcribed in leaves, disc flowers and anthers. Overexpression of both new open reading frames was cytotoxic for *E. coli*. With regard to the fertility restoration by restorer genes, markers linked to the corresponding restorer genes *Rf_PET2* and *Rf_PEF1* have been identified. Progress was made in the map-based cloning approach of the *Rf1* gene responsible for fertility restoration of the PET1 cytoplasm.

CHARACTERIZATION OF SLY1 IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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The phytohormone gibberellin plays a major role in the regulation of plant growth. Bioactive gibberellins stimulate essential processes including seed germination, stem and root elongation and transition to flowering. Although the main components of the gibberellin signaling pathway seem to be identified, it is apparent that not all mechanisms of regulation and interaction between the pathway components have been discovered up to now. The current understanding is that GA binds to a soluble GID1 receptor, which interacts with the DELLA repressor proteins in a GA dependent manner and induces the degradation of the DELLA proteins via the E3 ubiquitin ligase SCF^{SLY1} . The substrate specificity of the SCF ubiquitin ligase is realized by the F-box protein SLY1, which is an important positive regulator of the gibberellin signaling pathway (Thomas and Sun, 2004). Despite of the interest of breeding in the regulation of stem elongation and flowering time in sunflower, there is up to now little known about the specific regulation via gibberellins. Therefore, the objective of our research is to analyze the gene structure and the operating mode of the *sly1* gene in sunflower. Using a candidate gene approach the *sly1* gene in sunflower was isolated and characterized. Sequence analysis identified an open reading frame of 597 base pairs coding for a 198 amino acids protein. This protein shows high homologies to the functionally well characterized SLY1 of *Arabidopsis thaliana* and respectively to GID2 of *Oryza sativa* in the F-box and other characteristic domains. However, the sunflower protein is larger than the proteins from *Arabidopsis* or rice because it contains an additional serine rich variable region that is not found in the *At*SLY1 or *Os*GID2. This new serine rich region in the middle of the sunflower SLY1 protein shows a high probability for a phosphorylation site, which represents a promising new regulation site for the gibberellin signaling pathway in sunflower. In the 5'- flanking region of the *sly1* gene binding sites for regulatory elements were identified indicating a regulation of the SLY1 protein by light as well as by cold temperatures. First transcriptional analysis by RT-PCR confirmed a light specific regulation. Moreover, the response of different sunflower dwarf mutants to GA_3 treatments was investigated.

RECOMBINATION EVENTS INVOLVING THE *ATP9* GENE ARE ASSOCIATED WITH MALE STERILITY OF THE PET2 CYTOPLASM IN SUNFLOWER

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Cytoplasmic male sterility (CMS) is a maternally inherited incapacity of higher plants to produce or shed functional pollen. CMS is associated with mitochondrial rearrangements and the expression of novel open reading frames (*orfs*) composed of sequences of known mitochondrial genes and unknown origin. In this study, PET2, a new CMS-source derived from an interspecific cross of *H petiolaris Nutt.* and *H. annuus L.*, has been analyzed. Introduction of new CMS sources into commercial hybrid breeding to increase the variety in hybrids with regard to improved agronomic performance would be of great interest. To examine the PET2 cytoplasm in comparison to the male-fertile sunflower line HA89 and the PET1 cytoplasm, mitochondrial DNA was digested with *Hind*III, blotted using the Southern procedure and hybridized with the mitochondrial genes *atp6*, *atp9* and *cob* as. All hybridization signals were cloned and sequenced.. For the *atp6* as probe, one fragment of 1.3 kb identical in PET1, fertile and PET2 cytoplasm was detected as well as an additional fragment of 2.8 kb. The additional PET2 fragment contains a second intact copy of the *atp6* and seven *orfs*. For the *atp9* gene as probe, also one fragment of 3.5 kb identical in PET1, fertile and PET2 cytoplasm was detected as well as an additional fragment of 4.0 kb in PET2. The additional PET2-specific fragment contains a split *atp9* gene, which results in two new open reading frames of 228 bp and 231 bp, and three additional *orfs*. For the *cob* gene, an identical fragment of 7.0 kb was identified in all cytoplasms, which contains the 5'-coding region of the *cob* gene and a fragment of 3.0 kb in PET1 and the fertile cytoplasm, which contains the 3'-coding region of the *cob* gene, and a 5.0 kb fragment in PET2. The coding sequence of the *cob* gene proved to be identical in all cytoplasms. Only the two *orfs*, *orf288* and *orf231*, were unique to the PET2 cytoplasm, which was also supported by transcript analyses. Taken together, the two new *orfs*, the edited *orf231* (8.4 kDa) and the *orf288* (10.6 kDa) may be responsible for male-sterility in the presence of the PET2 cytoplasm.

CHARACTERIZATION OF DROUGHT STRESS ACCLIMATION IN SUNFLOWER *HELIANTHUS ANNUUS* L. C.V. PEREDOVICK

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Drought stress causes considerable yield losses in agriculture and receives high attention in crop breeding programs including sunflower. In order to have an easy manageable test system for drought resistance in sunflower, we developed an in vitro system to examine sunflower seedlings on MS media supplemented with polyethylene glycol 6000. Morphological and physiological parameters were compared between control and drought-stressed (-0.6 MPa) seedlings of *Helianthus annuus* L. c.v. Peredovick. The analyses of different growth parameters revealed a significant growth deficit of drought-stressed plants compared to control plants concerning hypocotyl length and development of primary leaves. Shoot growth was more affected than root growth resulting in an increased root/shoot ratio of drought-stressed plants. Gas liquid chromatography revealed an accumulation of inositol (65fold), proline (55fold), glucose (52fold), fructose (11fold) and sucrose (8fold) in leaves of drought-stressed plants, which may serve as osmolytes to compensate the lowered water content. Protein expression was analyzed by two-dimensional gel electrophoresis (2-D-PAGE) and MALDI-TOF mass spectrometry. A set of 46 protein spots allowed the identification of 19 marker proteins. Changes in protein expression (> 2 fold) of drought-stressed versus control plants were identified for six proteins: a putative caffeolyl-CoA O-methyltransferase (4.5fold induced), a fructokinase 3 (3.3fold induced), a vegetative storage protein (2.3fold induced), a glycine-rich RNA binding protein (2.2fold induced), a CuZn-superoxide dismutase (2.1fold induced) and an unknown low molecular weight protein (2.3fold induced). These proteins represent general stress proteins or proteins contributing to the basic carbon metabolism. These up-regulated proteins are potential candidates for selection for drought tolerance in sunflower.

TOWARDS A GENOMIC SEQUENCE FOR SUNFLOWER GENETICS AND BREEDING

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The *Compositae*, or sunflower family, is the largest plant family on earth, with over 24,000 described species, roughly 10% of all flowering plant species, including economically important crops, rare and beautiful wildflowers, common allergens, valuable medicinals and costly invasive plants and rangeland weeds. Despite the wide diversity and economic importance of plants in this family, there is no genome sequence for any of these species, or even any plants from closely related families, mainly because their genomes are all quite large. Here we announce the "Genome of sunflower" sequencing project. The genetic mapping part of the project will employ a 2.6 million-feature Affymetrix chip, which contains >90% of sunflower genes. Physical mapping will employ three BAC libraries aiming for global 12 x coverage, and use a novel sequence-based mapping approach (KeyGene), which will provide sequence tags every 2-6 kb across genome. Because of the size and complexity of the sunflower genome (3.5 GB), we will use a hybrid sequencing strategy, where Illumina and Roche 454 sequencing technologies are combined with sequence-based physical mapping. Genome pre-annotation (training gene predictor software EuGene and Fgenesh, building Helianthus repeat database) and annotation (Fgenesh + Eugene for protein-coding genes, LeARN for non coding RNAs, protein annotation based on Interpro-based domain content) will be developed in parallel with assembly and large BAC contigs genetic mapping. Having an entire genome sequence will facilitate scientific research across this diverse plant family, including insights into evolutionary genetics, and with applications ranging from crop improvement to weed control. This project has been funded by Genome Canada and Genome British Columbia, and benefits from in kind and financial support from DOE, INRA, USDA, UGA, and NSF.

LOOKING FOR SUNFLOWER *HELIANTHUS ANNUUS* GENES INVOLVED IN RESPONSE TO DROUGHT STRESS: WHAT CAN WE LEARN FROM EXPRESSION DATA IN USING THE 2.6 MILLION-FEATURE AFFYMETRIX® CHIP.

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An *Helianthus* Affymetrix ® microarray was designed in collaboration with researchers at the University of British Columbia, University of Georgia, Syngenta, and Biogemma). Probes for this chip were generated using 87,237 unigenes assembled from 284,251 Helianthus ESTs available at NCBI in September 2007 and covering seven different Helianthus species. A total of 72.372 unigenes (83%) were predicted to encode a peptide (Carrere *et al*., 2008), 24,799 of them encoding been full length proteins. The Affymetrix® chip is a whole transcript tiling array and contains 2,371,945 Helianthus probes, i.e. 27 probes per unigene on average. Given the presence within the assembly of a large fraction of sequences from six *Helianthus* species other than *Helianthus annuus*, we selected the probes matching perfectly with *H.annuus* ESTs and which, at the same time, present the highest conservation across species, in order to avoid a hybridization default due to genetic polymorphism. This probe subset corresponds finally to a total of ~27,200 unigenes. We carried out an experiment in glasshouse involving 8 *H.annuus* genotypes (5 inbred lines and 3 hybrids), 2 treatments (control/drought stress), 3 replicates and 2 sampling strategies. We thus produced 96 samples of leaves representing all developmental stages from before flowering time. Plant transpiration was daily monitored and sampling was then performed in 2 ways: (1) we fixed a harvest date, so different stress intensities were expected due to genotypic differences, and (2) we fixed a stress intensity (i.e. water soil content), available for each genotype a different dates. RNAs were extracted from each sample and Affy® chips were hybridized. Due to the factorial nature of the design, there was no obvious method for RMA normalization, and we performed such normalization per genotype, per treatment, per genotype*treatment combination, and over the total experiment. We then analyzed the sets of differentially expressed genes for each normalization method, focusing thereafter on their intersections. The experiment design allowed us to identify genes regulated according to the drought stress intensity and expressed in a genotype-specific manner in comparable drought stress conditions.

Key words: *Helianthus annuus*, microarray, Affymetrix, drought stress, transcriptome.

TWO GENOMIC BASED APPROACHES TOWARDS A BETTER SUSTAINABILITY TO SUNFLOWER *HELIANTHUS ANNUUS* RESISTANCE TO DOWNY MILDEW *PLASMOPARA HASLTEDII*

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As more and more *Pl* race specific sunflower resistance genes are overcome through the apparition of new races of Downy Mildew caused by the oomycete *Plasmopara halstedii* , we developed tools and strategies aiming to develop a better sustainability of resistance in sunflower varieties. First, following the discovery of a quantitative resistance to Downy Mildew (Vear et al., 2008), we developed a fine mapping of the major QTL located on linkage group 10 and explaining almost 40% of the variation in the RIL population derived from the cross XRQ*PSC8. We constructed and screened a BAC library from the RIL parent (XRQ) having the resistant allele with the closest genetic markers in order to build a BAC contig in the QTL region, a first step towards positional cloning strategy. The polymorphic BAC ends are currently being used as new genetic markers on the RIL population. We also developed new recombination events from an F2 population of 3500 plants and are currently phenotyping and genotyping the F5 recombinant progenies. Secondly, in order to improve the availability of pertinent genetic tools for the survey of this obligatory parasite on the crop territory, we produced cDNA from infected susceptible and resistant plantlets, and sequenced them using the 454® pyrosequencing technology. We identified by in silico filtering a few hundreds of novel *Plasmopara halstedii* EST sequences. Up to now, 60 of them have been checked as true *P. halstedii* sequences through positive amplification on *P. halstedii* genomic DNA and no amplification on *Helianthus annuus* genomic DNA. Some of these sequences are presenting strong similarity with known oomycete pathogenicity effectors (RXLR, Crinkler).

Key words: *Plasmopara halstedii*, *Helianthus annuus*, QTL, quantitative resistance, cDNA sequencing

REGENERATION AND GENETIC TRANSFORMATION OF RUSSIAN SUNFLOWER CULTIVARS AND PRODUCTION OF HERBICIDE-RESISTANT PLANTS

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Developping genetically modified plants is very difficult in sunflower. The progress of sunflower genetic transformation is restricted by the limitations of available regeneration system and difficulties in combining regeneration and transformation within the same cells. The purpose of our research was to work out effective ways of regeneration and transformation of commercially valuable sunflower breeds (*Helianthus annuus* L.) of Russian selection.

We have reached the following results:

1. An efficient method for sunflower seed sterilization that allows obtaining a 100% yield of aseptic seeds for *in vitro* culturing has been worked out.
2. A genotype-independent protocol for the in vitro shoot regeneration from sunflower seeds was optimized. Frequency of shoot regeneration ranged from 83.5% to 90.3%.
3. Four transgenic sunflower plants (T_0) with the expressing gene *bar* were produced.
4. The inheritance of heretologous gene in two generations of transgenic sunflower plants is shown for one transgenic line.

PART III: MOLECULAR BREEDING

BIOTECHNOLOGICAL METHODS USED IN SUNFLOWER

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Sunflower (*Helianthus annuus* L.), is one of the Turkey's and world's major oilseed crops. Sunflower oil contains a higher proportion of unsaturated fatty acids than other vegetable oils and is therefore useful as a raw material in the production of biodiesel. The technology for processing sunflower oil into biodiesel has recently been developed; consequently, the importance of the sunflower is increasing. To get higher yields in sunflower, new gene sources should be obtained from wild types via interspecific hybridization using molecular breeding methods. In vitro culture, genetic transformation and molecular marker techniques such as PCR, RFLP etc. have been successfully used up today in sunflower.

Keywords: Sunflower, biotechnology, *Helianthus annuus* L.

USE OF SSR MARKERS IN IDENTIFICATION OF SUNFLOWER ISOGENIC LINES

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Downy mildew resistance gene *Pl6* was introduced into several sunflower commercial inbred lines by recurrent selection. Similarity of obtained lines to their respective original, non-resistant line was checked with randomly chosen set of SSR primers. The aim of the work was to find either isogenic or the lines with the greatest similarity to the original line, and to check if chosen SSR primers could be used for this purpose.

INFLUENCES OF GENOTYPE AND EXPLANT ON CALLUS INDUCTION AND SHOOT REGENERATION IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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In vitro regeneration was performed with the aim of developing efficient callus and shoot regeneration from different explants of sunflower (*Helianthus annuus* L.). Six genotypes (RHA10, RHA 14, RHA15, PR6404, N Record 109/ Sanay 3-5, N Record 109/ Sera) were used as plant materials. The roots, hypocotyls and cotyledons were excised from 4 day-old seedlings and cultured on embryo induction medium (EIM) supplemented with benzylaminopurine (BAP), Naphthaleneacetic acid (NAA) and Gibberellic acid (GA_3). The experiments were kept in 18/6 hour light/dark photoperiod at 26± 2 ^{0}C for two weeks. The rates of callus and root organ formation on callus were 67-100% and 7-31% respectively, depending on the genotype. Root explants produced statistically high callus formation (2.61a) compared to cotyledon explants (1.94b) and hypocotyl explants (2.48ab) for all sunflower genotypes used. The highest shoot regenaration was obtained from RHA15 (7%) while PR6404 produced the highest callus formation (100%).

Key words: Sunflower, callus induction, shoot regeneration

REGENERATION OF FERTILE PLANTS FROM SUNFLOWER (*HELIANTHUS ANNUUS* L.) – IMMATURE EMBRYO

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Immature embryos from 15 sunflower genotypes (5 restorers, 5 cytoplasmic male steriles and 5 maintainers) were studied for shortening the seed to seed cycle because of seed maturation in sunflower takes 50-60% of the life cycle duration (120-150 days). This technique allows the production of fertile plants from immature embryos by reducing the breeding cycle. Immature embryos of 10 days after pollination were dissected from seeds grown in the field plants (SGFP), were transferred to MS medium allowing shoot and root development for 5-10 days. Young plantlets transferred to soil, developed to maturity and were then self pollinated and seed-set. The first cycle of immature embryo-raised plants (ERP) was obtained. When these plants were at flowering stage, 10 day old embryos were dissected and 2nd cycle of ERP was obtained. The plants at the flowering stage for obtaining 3rd cycle are in the growth chamber at the moment. The cultured embryos developed into vigorous plantlets with 3-6 leaves. Out of 1710 immature embryos, the average response of the explants was 93.1% (1591) showing morphogenesis with a minimum of 42.5 (N Record 109/Sanay 1-2(N) and a maximum of 100% (PR6404(CMS), Narmo Sanay 6-1 (CMS), RIM 1-5 (CMS), BGC0565 (N), N Record 109/Sera (N), RHA 04, RHA 06, RHA 14, RHA 15). 70% of the developed plantlets had vigorous roots. They were transplanted into pots containing a 1:1:2 peat: perlite: soil mixture (v/v) at 24 ± 2^{o}C in 16h/8 h (light/dark) in a growth chamber. Only 67.3% of them reached maturity, and were then either self-pollinated or pollinated with maintainers for seed set. On average 40-50 regenerated and matured plants per 100 immature zygotic embryos were obtained.

Key words: Sunflower, immature embryo, fertile plant regeneration.

BIOLOGICAL CONTROL OF SUNFLOWER DAMPING-OFF AND CHARCOAL ROT DISEASES

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To enhance the role of biocontrol and evaluate certain bioagents on control of sunflower diseases, three isolates of *Trichoderma harzianum* Rifai and *Bacillus subtilis* (Ehrenberg) Cohn, two isolates of *Trichoderma hamatum* (Bonord.)Bainier and one isolate of *Trichoderma viride* Pers, *Trichoderma koningii* Oudem, *Trichoderma pseudokoningii* Rifai, *Gliocladium catenulatum* Gilman. & Abbott, *Cunninghamella echinulata* Thaxter, *Penicillium oxalicum* Currie & Thom, *Penicillium chrysogenum* Thom and *Bacillus cereus* Frankland & Frankland were isolated from sunflower rhizosphere. These isolates were able to inhibit the growth of *Macrophomina phaseolina* (Tassi) Goid, *Fusarium oxysporum* Shelecht., *Fusarium verticillioides*. Sacc. (*F. moniliforme* Sheldon.), and *Rhizoctonia solani* Kuhn., the causal pathogens of sunflower damping-off and charcoal rot, *in vitro*. *Trichoderma spp*. isolates gave highest antagonistic effect than other bioagents isolates. Under greenhouse conditions, application of *T. harzianum* (E17b & E17c), *T. hamatum* (E19a), *T. koningii* (E21) and *G. catenulatum* (E18) separately to soil infested with pathogens caused significantly increases in surviving plants. The results showed that the percentage of infection was significantly affected by bioagents. The application of bioagents reduced the percentages of infection as compared to the control. In general the application of *G. catenulatum* produced the highest value (83.33%).

Key Words: *Trichoderma harzianum; T. hamatum; T. viride; T. koningii; T. pseudokoningii; Gliocladium catenulatum; Cunninghamella echinulata; Penicillium chrysogenum; P. oxalicum; Bacillus cereus; B. subtilis; Macrophomina phaseolina; Fusarium oxysporum*; *F. verticillioides*; *Rhizoctonia solani.*

MAPPING INTROGRESSION FROM *HELIANTHUS MOLLIS* LAM. INTO SUNFLOWER (*H. ANNUUS* L.) CROP AND NEW COMPACT CROP ARCHITECTURE

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We investigated the sunflower introgression line HM374 derived from *H. mollis*, which was constructed using the backcross method. The whole backcross progenies along the experimental process were genotyped with AFLP markers to verify and unravel which events may have occurred at each generation. One first generation hybrid plant was verified by GISH and one BC_1 plant (#17) was backcrossed with sunflower. All further generations were obtained by self-pollinating of the BC_2 plants. Several tens of progenies were developed segregating for more or less compact architecture (short internodes, short petioles, small leaves, acute angle leaf stem) and bumpy and corrugated leaves. Although the number of plants was low we applied AFLP markers onto 48 BC_2 progenies from 21 BC_1 plants, enabling us the elaboration of a genetic map with 93 AFLP markers, out of 170 *H. mollis* markers. We found 3 groups of markers from *H. mollis* that intervened in the compact architecture and one unlinked marker explained variation for the bumpy and corrugated leaves. The line HM374 was crossed with RIL75OL to produce F1 and F2 progenies enabling us to broadly localise introgression using SSR markers, but due to weak polymorphisms in sunflower and no transfer of sunflower markers to *H. mollis* the work should be reconsidered with other tools. Introgression fragments into sunflower from perennial *Helianthus* are important to transfer genes for disease and parasitism resistances. It is the first case of mapping introgression from a perennial *Helianthus*.

Keywords: AFLPs , architecture, *Helianthus*, introgression line, perennial, QTLs.

GENETIC VARIABILITY OF GERMINATION PARAMETRES IN SUNFLOWER MUTANTS UNDER DROUGHT STRESS

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Seed germination and early seedling growth are the most sensitive stages to environmental stresses. One way to create genetic variability in cultivated sunflower is to induce mutations by irradiation with gamma rays or chemical mutagens. Mutagenesis has been also successfully used for developing variation in the fatty acid profile of sunflower. The objective of the present research was to study 30 mutants, induced by gamma irradiation among a population of M6 sunflower mutant lines and to identify molecular markers associated with different seed germination traits. The experiments were performed under control and water-stressed conditions using randomized block design with three replications. The studied traits consisted of critical times and percentage of seed germination (PSG). Water treatment presented significant effect for all the traits. Also there are differences between the mutants in term of their response to drought. Some mutant lines were significantly different for most of germination parameters when compared with the original line (AS613). High negative significant correlation was observed between PSG and critical times of germination. Multiple regression analyses show that some AFLP markers are associated with several traits. The most important AFLP markers were "*E37M62-5*"*," E33M60-6"* and *"E40M59-7"*, *w*hich have no interaction with water stress. Several markers are associated with seed germination parameters in both conditions. The specific markers were also detected for each trait under both conditions. Markers associated with different traits in control and water-stressed conditions could be used for marker-assisted selection in both environments.

Key words: Water stress, critical times of germination, AFLP markers, mutant- sunflower.

SNP MARKER DEVELOPMENT IN SUNFLOWER

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SNP (single nucleotide polymorphism) markers are a molecular marker system that permits the genetic analysis of organisms with large numbers of molecular markers in a cost-efficient way. In order to identify a set of SNP markers that can be used for genetic analyses and breeding in sunflower, we have started amplicon sequencing of sunflower genes based on EST sequences. Until now, we have analysed more than 2250 amplicons derived from sunflower genes for the presence of SNPs in a panel of 12 lines and pools through Sanger sequencing. This resulted in the identification of more than 11000 high quality SNPs and a considerable number of InDels (insertion/deletions). Furthermore, the data set has been analysed with respect to the level of polymorphism between the individual lines, the number of observed haplotypes and the number of markers that can be used for the design of Illumina assays.

GENETIC DISTANCE AND HETEROSIS FOR YIELD COMPONENTS IN HYBRID COMBINATIONS OF INBRED LINES FROM INTERSPECIES CROSSES

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Four interspecies populations, originating from three annual (*H. debilis, H. praecox, H. deserticola*) and one perennial (*H. resinosus*) wild species, were used to produce 16 new CMS inbred lines, in order to increase genetic variability of cultivated sunflower. These lines were crossed with three Rf inbred lines, in a line x tester mating design, which resulted in 48 F_1 hybrids. Several agronomic traits were measured in one location and two seasons. The genomic DNA polymorphism of parental lines was investigated by simple sequence repeats (SSR) markers distributed over all linkage groups. SSR markers were selected either for their previously estimated high polymorphic information content (PIC) values or expressed sequence tags/quantitative trait loci (EST/QTL) associations. Genetic distance (GD) between all pairs of examined sunflower lines calculated from molecular data varied in a broad range from 0 to 92 %. The correlation between GDs and absolute mid-parent heterosis (AMPH) was analyzed for seven agronomic traits. Significant linear correlations between AMPH for the most important yield components and GD that were found for one tester were not necessarily detected for the rest of the testers. The variability of new CMS inbred lines was high according to all measured phenotypic traits, and most yield components were significantly higher than in Rf inbred lines. The performance of all F_1 hybrids overcome parental lines, especially for the seed yield per plant, which was mostly doubled, even tripled in some cases.

DNA-TECHNOLOGY FOR SUNFLOWER BREEDING AND SEED PRODUCTION IMPROVING

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Polyloci and monolocus marker systems were used to investigate the genetic diversity of sunflower genotypes of Ukrainian breeding. An approach for variety identification and genetics formula constructions are proposed. A panel of 16 microsatellite loci that showed a high degree of polymorphisms was used to identify lines and hybrids created in the different Ukrainian breeding centers. A DNA marker linked to the race C broomrape resistance gene was identified in sunflower.

Key words*:* DNA-markers, genotyping, *Helianthus,* identification, microsatellites, PCR.

TOWARD MARKER ASSISTED SELECTION IN BULGARIA. DEVELOPMENT AND MOLECULAR CHARACTERIZATION OF BREEDING LINES DERIVED FROM INTER-SPECIFIC HYBRIDS

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Sunflower is the most important oil crop in Bulgaria. During the last decade, extensive breeding programs in Bulgaria were launched for the improvement of the disease resistance and the quality of sunflower through intraspecies and interspecies hybridization for achievement of low cost and environmentally friendly production. Interspecific hybridization between *Helianthus annuus* L. and *Helianthus bolanderi* was used for the development of inbred lines. Two lines, 2530-R and 2534-R, derived from F8 generation of *H. bolanderi x H. annuus* hybrid were studied. Both lines possess resistance to downy mildew and several other new breeding traits. The genomic constitution of these inbred lines and chromosomal regions introgressed from the *H. bolanderi* were determined through analysis with microsatellite markers, uniformly covering the sunflower genome. Two F2 segregating populations were established, following the backcross between line HA89 (susceptible) and lines 2530 and 2534 (resistant). The ongoing phenotypic and molecular analysis of F2 populations aims at the identification of chromosomal regions introgressed from the *H. bolanderi*, which underlie the resistance to P. *halstedii* and other agronomic traits. A marker assisted selection program for breeding of new downy mildew tolerant lines with improved agronomic characters is in progress.

ACCELERATED INTROGRESSION OF DROUGHT-RESISTANT GENE(S) FROM *HELIANTHUS ARGOPHYLLUS* TO *HELIANTHUS ANNUUS* L., USING EMBRYO RESCUE TECHNIQUES

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In order to improve drought resistance of sunflower in the context of the global warming and to accelerate this improvement, introgression of resistance genes from wild species was attempted, using embryo rescue techniques, combined with classical procedures to improve crossing, selfpollination and backcrossing. Thirty four approved or pending approval lines (B and C) were tested for combination capacity with the wild *Helianthus argophyllus*. After crossing between *H. annuus* and *H. argophyllus*, 6 generations in two years (2008-2009) were obtained, as follows: F1 (interspecific crossing - harvest immature hybrid embryos), generation 2 (BC 1); generation 3 (selfpollination); generations 4, 5, 6 (BC2-BC3-BC4). In case of the crossing between species *H. annuus* and *H. argophyllus* only four generations in 2 years were obtained, due to the long vegetation period of the wild species, the large number of training (25 days) to head, the high degree of branching and not finally high incompatibility between the two species.

Key words: Sunflower, immature embryos, embryo rescue, interspecific crossing.

PART IV: CONVENTIONAL BREEDING

ASSESSMENT OF GENETIC DISTANCE AS A PREDICTOR OF SUNFLOWER HYBRID PERFORMANCE

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In an attempt to examine the possibility of heterotic group determination in sunflower, the genetic distance between 18 restorer lines and 31 maintainer lines was calculated based on morphological characteristics. Cluster analysis and biplot analysis based on Factor analysis simply separated R-lines and B-lines. In order to obtain groups with both R-lines and B-lines, several methods were assessed, and among them, cluster analysis with the four factors with eigenvalues larger than 1 could make mixed groups. Based on distances on cluster diagram, 7 restorers and 8 CMS lines were chosen, in such a way to cover near, medium and far genetic distances. Analysis of variance revealed significant differences for seed weight and yield between the distance classes. Farthest distances produced highest yields and seed weights followed by medium and near genetic distance, respectively. The yield of each parent was regressed with its average distance with opposite sex parents and again, parents with farthest distances produced highest yields. Results suggested that determination of heterotic groups in sunflower could provide promising results.

Key words: Sunflower, heterotic groups, heterosis, yield prediction

EVALUATING THE GCA AND SCA OF NEW IMPROVED SUNFLOWER CMS AND RESTORER LINES

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In order to evaluate general combining ability, specific combining ability and gene effects of 4 lines and 3 testers of oilseed sunflower, they were crossed based on line X tester mating design at the Agricultural Research Station of Gonbad in 2007. In 2008, an experiment comprised of 12 F1 crosses, 3 female, 4 male parents as well as Azargol (check) was carried out in an RCBD with 3 replications at the same location. Effects of genotype, parents and crosses were significant for all traits studied with the exception of stem diameter for crosses and head and stem diameter for parents. Partitioning crosses effects to its components showed significant effects of lines on plant height and oil yield. It also revealed that plant height, seed and oil yield were significantly affected by testers. Line by tester Interaction had a significant effect only on duration and head diameter. Estimating GCA of lines and testers indicated that, tester 1 and lines 1 and 2, were good combiners for decreasing growth duration of their crosses. Also tester 1 could be utilized to reduce plant height of its hybrids. The GCA of parents revealed that testers 1, 2 and line 1 were best combiners for improving seed and oil yield of their crosses. Heterotic effects were noticeable for all traits evaluated with the exception of growth duration and oil content. In this study 4 hybrids were promissing crosses for seed yield. Genetic variance components indicated that, with respect to seed and oil yield inheritance, contribution of estimated additive variance was more than that of non-additive variance. Therefore in order to improve these traits, applying recurrent selection method could be considered as the most suitable approaches.

Key words : Sunflower, GCA, SCA, heterosis

LINE X TESTER ANALYSIS OF YIELD AND SOME YIELD RELATED TRAITS OF SUNFLOWER

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In order to evaluate GCA and SCA of 5 testers and 5 lines of oilseed sunflower, they were crossed at the Agricultural Research Station of Gonbad in 2006. An experiment, comprising 25 sunflower hybrids as well as Hysun33 (check), was conducted in an RCBD with 3 replications at the same location in 2007. Effects of genotypes and crosses were significant on all traits studied with the exception of head diameter. Partitioning crosses effects to its components revealed that effects of lines on all traits evaluated were significant. Testers had the same effect with the exception of oil content. GCA of lines and testers showed that testers 1 and 5, lines 3 and 4 were the best parents for earliness and decreasing height due to their negative and significant GCA for these traits. Tester 2 and lines 2 and 5 due to their significantly positive GCA effect may be used to increase oil content, grain and oil yield of their hybrids. In this study highest yields belonged to T2 x L5 and T2 x L2 with 2.626 and 2.442 t/ha grain yields, respectively. They showed significant superiority over the check Hysun-33 for grain and oil yield. Genetic variance components revealed that, in most evaluated traits of the crosses, estimated additive variance had more contribution than that of non-additive one. Therefore breeding programs might be adopted based on classic methods (selection), recombination and test cross approaches.

Key words: Sunflower, GCA, SCA, heterosis.

RECENT ACHIEVEMENTS OF SUNFLOWER BREEDING

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Global sunflower breeding has managed to achieve significant results in recent times thanks to the use of the latest conventional breeding methods as well as by an increasing use of marker-assisted selection (MAS). These results have made it possible to develop sunflower hybrids that are more productive, adaptible, and stable than those of the previous generation. Of special note is the progress that has been made in increasing the genetic variability of the cultivated sunflower through interspecific hybridization with the wild species of the genus *Helianthus*. The wild species have provided a number of important genes that have been incorporated into cultivated sunflower genotypes. These include genes for resistance to downy mildew, rust, Verticillium, powdery mildew, and broomrape (races A-F) as well as genes for high tolerance of Phomopsis, Macrophomina, Albugo, and Alternaria ssp. Noticeable progress has also been made in breeding for resistance to abiotic stresses (drought, high temperatures). In the last two to three years, new races of broomrape have appeared in a number of countries. To combat this, sunflower breeders and geneticists will have to make greater use of biotechnology (marker genes) in their search for new sources of broomrape resistance and their study of *Orobanche* resistance at the molecular level. Using induced mutations, high-oleic sunflower hybrids have been developed. Spontaneous and induced mutations have also been used to obtain genes for different types and amounts of tocopherol (alpha, beta, gamma, delta). The mutants for tocopherols in combination with those for fatty acids can now be used to develop sunflower hybrids with novel types of oil. Important results have also been achieved in making use of wild sunflower species to obtain mutant lines tolerant of imidazolinone- and sulfonylurea-base herbicides, which can be used to develop new types of hybrid sunflower. A lot of progress has also been made in the improvement of other agronomic and biological traits of sunflower.

Key words: Sunflower, breeding, resistance, quality, productivity, molecular markers.

ESTIMATION OF GENETIC PARAMETERS IN SUNFLOWER SINGLE CROSS HYBRIDS

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Estimation of genetic variance components and heritability and having knowledge about genetic diversity of evaluated materials are one of the important pre-breeding activities in breeding field crops. For the estimation of genetic parameters in sunflower single cross hybrids, a North Carolina Design I experiment was conducted in a randomized complete block design in three replications at Agricultural and Natural Research Station of Khoy. In 2005, six fertility restorer male lines were crossed with 18 cytoplasmic male sterility female lines. Each male line was crossed with three different female lines to make two sets with nine hybrids in each set. In 2006, Single cross F_1 hybrids were planted for estimating genetic parameters. Data were collected from agronomic traits including: flowering initiation, seed filling period, maturity, plant height, stem diameter, head diameter, 1000 seed weight, seed numbers per head, grain/achene ratio, biological yield, harvest index, oil content, seed yield and oil yield. Survey results showed that gene action in some loci for 1000 seed weight and seed numbers per head was partial dominant ($\bar{a} < 1$), for oil yield were complete dominant ($\bar{a} = 1$) and for other traits, it was over-dominant ($\bar{a} > 1$). To improve seed filling period and harvest index traits, use of selection method is sufficient. In traits such as plant height, stem diameter and head diameter, it is unavoidable to use the hybridization method to improve them. For other important traits including seed yield, oil yield and biological yield, it is recommended to use both selection and hybridization method. Regression analysis and path analysis indicated that final selection must be done by considering optimum amount of 1000 seed weight and seed numbers per head. Principle components analysis indicated that first component with high amount of total variance and high correlation with traits including seed yield, oil yield, seed numbers per head, oil content and harvest index can be appropriately useful in rapid selection and screening of genetic materials in primary stages.

Keywords: Genetic variance components, hybrid, North Carolina Design I, sunflower.

NON-GMO IMIDAZOLINONE HERBICIDES-TOLERANT SUNFLOWER GENOTYPES, OBTAINED AT NARDI FUNDULEA

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In Romania, sunflower is grown on about one million ha in the southern, southeastern and western parts. The soils are strongly infested with annual and perennial weeds, mono- and dicot species, with a predominance of *Xanthium strumarium* and *Cirsium arvense*. Worldwide, the discoveries allowed the first IMI resistant (IMI tolerant and IMI resistant types), genetically unmodified sunflower hybrids to be obtained. This prospect was very exciting because the list of broadleaf weeds and grasses controlled by imazethapyr herbicide and other herbicides of the imidazolinone chemical family (IMI), was extensive. Also, for sunflower, to spread into no-till acreage, planting herbicide tolerant hybrids was the only alternative for postemergence weed control. Using a population of wild *H. annuus* from Kansas, USA, in 2002, Miller and colleagues released two germplasm lines of imazamox (the new BASF IMI herbicide)-tolerant sunflower for commercial seeds companies to be used in developing their own hybrids. At NARDI Fundulea in the sunflower breeding program we started the conversion of our best valuable inbred lines into IMI herbicides tolerant ones, by collaboration with BASF Company. Part of these lines is already finished in this conversion process, due to the use of „embryo rescue" method and to the greenhouse generations of selection. The herbicide Pulsar has been used for the treatment of sunflower plants in the process of choosing resistant or tolerant ones, in different generations of selection. In 2008, we started to use the new source of resistance to IMI herbicides, created by BASF in collaboration with Nidera, Argentina. This new source is conferring a better resistance to these types of herbicides, making it possible to have a very good control of the weeds as well as of the parasite *Orobanche cumana*, as our research results are showing. Sunflower tolerance to IMI herbicides offered an excellent opportunity for chemical control of the parasitic weed *Orobanche cumana* Wallr. *Orobanche* chemical control is not race specific and may serve both to prevent the parasitic plant to spread to new areas and to control it in already infested areas. The performance of five experimental hybrids, resistant to IMI herbicides was studied in two locations of southeastern Romania, in 2009. Herbicide treatments significantly reduced broomrape infestation across the two locations, raising sunflower seed yield.

Key words: sunflower, Imidazolinone herbicides, genetic resistance, weeds control.

SELECTION IN SUNFLOWER (*HELIANTHUS ANNUS L*) INBRED LINES RESISTANT TO BROOMRAPE

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Orobanche belong to Orobanchaceae family. There are approximately 12 genus and 200 species of this family in the northern hemisphere. Common Orobanche species attacking to the cultural plants in Iran and Turkey are *Orobanche ramose*, *Orobanche cumana* and *Orobanche speciosa*. It is believed that *Orobanche ramose* was introduced into the other regions from China with hemp. *Orobanche ramose* is seen in many places in Turkey and Iran also. It was seen on tobacco, hemp, tomatoes, eggplant, pepper, cabbage, radish, cucumber, carrot, hop, potato and sunflower in Turkey and Iran. *Orobanche cumana* is mostly seen on sunflower. It is widespread in sunflower fields in Marmara region. There is no clear evidence when *Orobanche cumana* introduced into Turkey. It is estimated that this species was introduced 80 years ago. The research was conducted on the experimental field of the Department of Field Crops, Faculty of Agriculture, and at the University of Ankara. The experiment was arranged as randomized block design with four replications. The aim of this research was to determine of various characters like resistance to broomrape, hull percentage, and oil percentage in 5th generation selfed sunflower lines of V.8931 and Ekiz1. For the inbred lines of Ekiz1/1, Peredovik/1, and Peredovik/3 broomrape was not found. Frequencies ranged between 1-10% for the inbred lines of V.8931/1,V8931/2, V8931/3, V8931/4, Ekiz1/3, V1646/2, V1646/3, V1646/4 and Peredovik.

Key words: Resistance to broomrape, *Orobanche cumana*, inbred line, oil yield, oil percentage, broomrape frequency

SUNFLOWER (*Helianthus anuus* L.) LANDRACES OF TURKEY, THEIR COLLECTIONS CONSERVATION AND MORPHOMETRIC CHARACTERIZATION

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Turkey is important country for the plant genetic resources. The conservation of plant genetic resources is important for the sustainable protection of genetic diversity. Since the new uniform and high yielded varieties used in modern agriculture may cause the erosion of genetic diversity of local or landraces. The collection and characterization of local germplasm become necessary. Sunflower (*Helianthus annuus* L.) is one of the important crops for Turkey and sunflower landraces show significant diversity in Turkey as being one of the "Micro-Gene Center" for sunflower. Therefore, sunflower landraces were collected within the framework of "National Industrial Plant Genetic Resources Project". Those accessions were maintained long term as *ex situ* at National Gene Bank and characterized for better understanding the eco-geographic variation of sunflower landraces throughout region and for assessing sustainable utilization of those collections. The eco-geographical distribution of the land races and agro-morphological variation of sunflower collection at National Gene Bank will be presented. Amount of diversity, the genetic resources of sunflower used as source of morphological similarity or dissimilarity of sunflower genetic resources were analyzed. Sunflower accessions used in this study, in which were collected from different sites of Turkey, were evaluated for morphological characters. Ecological differences affect morphology of sunflower; thus, quantitative aspects of variation were evaluated using plants grown under same conditions. Multivariant analyses were performed for diversity determination of sunflower and morphometric parameters were examined. The distribution areas of sunflower samples showed great diversity. The distinct groupings were determined in principal components and the results of analysis exhibited broad morphological variation model of sunflower land races.

Key words: Sunflower, *Helianthus annuus* L., *Ex situ* conservation, diversity, agro-morphological variation, eco-geographical variation, Multivariant analysis, Principle Component Analysis (PCA).

THE STUDIES ON THE DETERMINATION OF THE COMBINING ABILITY OF INBRED LINES FOR HYBRID BREEDING BY USING LINE X TESTER ANALYSIS IN SUNFLOWER (*Helianthus annuus* L.)

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Combining ability studies in oilseed sunflower were undertaken with a set of 5 x 4 line x tester including parents for the characters; seed yield, 1000-seed weight, days to flowering, days to physiologic maturity, plant height, head diameter, stem diameter, oil content, fatty acid content (oleic, linoleic, palmitic, and stearic acids), protein content, seed length, seed width, and hull percentage. General (GCA), specific combining ability (SCA), and heterosis of inbreed lines and their hybrids were estimated in a line x tester analysis at main and second crop production seasons in Menemen, Izmir - Turkey. The variances due to GCA and SCA were highly significant for most of the characters under both environments. The ratio (H/D)1/2 and σ^2 GCA/ σ^2 SCA depicted the preponderance of non-additive type gene action for all the characters except plant height, head diameter, seed length, palmitic acid content, and stearic acid content. However, both types of gene action were observed for seed yield, hull percentage, 1000-seed weight, oil content, and stem diameter at stem curve point. In this study, GCA effects were found highly significant for all traits while SCA effects were non-significant for most of the traits. Based on GCA effects under main and second crop production seasons, the inbreeds, 0043 CMS, 0046 CMS, 0195 CMS, 0583 CMS, 0704 CMS, 0708 Rf, 0845 Rf, 0951 Rf, and 1097 Rf exhibited desirable GCA effects, and were found to be good general combiners for most of the traits; thus they can be exploited by further breeding for developing superior genotypes and hybrids in sunflower.

Keywords: Sunflower, *Helianthus annuus* L., hybrid, breeding, genetics, general combining ability (GCA), specific combining ability (SCA), heterosis.

SUNFLOWER (*Helianthus annuus* L.) RESEARCHES IN AEGEAN REGION OF TURKEY

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Sunflower is one of the important oilseed crops in Turkey (577.958 ha area and 992.000 MT production) and could be grown at both main and second crop production seasons in the Aegean Region with high yield capacity. Because of the gap in the vegetable oil production in Turkey, it is one of the alternative and leading oilseed crops to increase vegetable oil production as second crop in the Aegean Region. The mission of the Oilseed Research Project at AARI Institute is to reduce the cost of sunflower production by improving well adapted and high yielding varieties. Improved germplasm for hybrid development and breeding lines of oilseed and confectionary type of sunflower (A, B and Rf lines) and also improved populations have been developed by conventional breeding techniques. To improve sunflower varieties with desired characters, genetic investigations and germplasm development of sunflower with improved yield, oil quality, resistance to rust, insect, *Orobanche* sp., and adverse conditions are under consideration. The research program is leading to develop oilseed and confectionary type of sunflowers for both main and second crop production seasons. Sunflower germplasm have been developed from sources such as cultivars, populations created through breeding methods or inter-specific crosses with wild germplasm, and tested for general and specific combining ability, oil percentage, and resistance to prevalent disease and adverse conditions to construct improved varieties. Combining ability studies in oilseed and confectionary sunflower breeding program were undertaken with line x tester analysis. More than 2000 lines, candidate variety and commercial variety evaluated in preliminary and yield trials under first and second crop production season. Variety performance tests and yield trials indicated that sunflower can grow with satisfactory yield performance (approximately 5000-5500 kg ha^{-1}) at both main and second crop production seasons in Aegean Region of Turkey. Improvement of oilseed and confectionary type of sunflower germplasms (A, B and Rf lines) including hybrid and open pollinated variety have been developed. Oilseed type of open pollinated Ege-2001 variety was developed by using S 0:1 generation testing method (recurrent selection) and has been registered. Effect of plant population, planting time, fertilizing, irrigation, honeybee pollination, on seed yield, oil percentage and other plant characteristics, and silage quality of sunflower were determined. Sunflower rust race identification under field conditions was determined.

Keywords: Sunflower, breeding, genetics, germplasm, hybrid variety, open pollinated variety, agronomy, adaptation, CMS line, restorer line, diseases, insects and weeds, yield components.

THE CURRENT SITUATION OF BROOMRAPE PROBLEM IN SUNFLOWER PRODUCTION, THE SOLUTIONS AND FUTURE DIRECTIONS IN TURKEY

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Turkey exists among top ten sunflower producer countries in the world. Broomrape (*Orobanche cernua* Loeffl.), weed control and some diseases such as downy mildew, Sclerotinia, Macrophomina, etc.. are the main problems of recent years in Turkish sunflower production. Broomrape affects 72 % of Turkish sunflower production (600-700.000 ha) which mainly located in Trakya Region which is European part of Turkey. Genetically resistant and Imidazolinone (IMI) herbicide resistant sunflower hybrids called as CLEARFIELD system are the main and effective way to solve broomrape problem both in Turkey and the world. New races of broomrape observed in Turkey, Spain, Bulgaria, Romania, Ukraine and Russia in recent years and there is no developed sunflower hybrid 100% resistant to these new races due to high overcoming virulent capability of broomrape against these resistance genes. Because of that point and also presenting an effective way to control key weeds such as *Xanthium strumarium* L*., Sinapis arvensis* L., *Chenopodium album* L., *Cirsium arvense* Scop., *Avena spp., Amaranthus spp. Convolvulus arvensis* L., *Datura stramonium* etc.. in sunflower production, the market share of IMI herbicide resistant sunflower were rapidly increased in recent years in Turkey. CLEARFIELD system is firstly started in 2003 in Turkey, and then IMI type hybrids selling was tripled in 2006 reaching about 45-47% in Trakya Region and 25% of Turkish sunflower seed market which is about 2.000-2.200 MT currently. Due to most areas broomrape infested, 46% IMI, 50% genetically resistant and 4% non resistant sunflower hybrids were planting in Trakya region. However, all new developed hybrids to broomrape are not completely resistant; some broomrape plants were observed in the fields and increase the numbers year by year. However it is not proved that, they were new races or sub-races or resistant hybrids could be categorized into highly tolerant even not affected seed yield much. On the other hand, there are some hesitations and complaints by farmers on soil residues and affected following crops (mostly wheat) in the rotation. Commercial herbicide consisted *Imazamox+Imazapyr* (33+15 g/l) used currently in Clearfield system in Turkey but *Imazapyr* exists banned list EU list now and new commercial herbicide should be presented to market rapidly. New herbicides consisting *Imazamox* or others only from IMI group could reduce the number of weed and could result control problems like *Sulfonyl Urea* group in sunflower production in Turkey.

Key Words: Sunflower, broomrape, hybrid, genetically resistance, IMI herbicide resistance,

DEVELOPMENT AND STABILITY PERFORMANCE OF SOME SUDANESE SUNFLOWER HYBRIDS UNDER IRRIGATED CONDITIONS

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Sunflower (*Helianthus annuus* L.) is a new edible oil crop in Sudan. Many production constraints are responsible for fluctuation in area and productivity. The main constraint is lack of adapted, improved, high-yielding sunflower varieties, leading farmers depending on imported seeds, which are usually unavailable and expensive. To reduce the cost of seed and ensure seed supply at the optimum time, ten developed single-cross sunflower hybrids (SFH32, SFH36, SFH37, SFH310, SFH313, SFH314, SFH341, SFH345, SFH302 and SFH325) and Hysun-33 as a check were evaluated with respect to yield and its components. The experiments were laid-out in a randomized complete block design with three replications over five irrigated locations during winter season 2008/2009. There was considerable variation for yield and its components among both hybrids and locations. Significant differences were observed for hybrids (G), locations (E) and GxE interaction. All the genotypes recorded high seed and oil yields under irrigated condition. Over five environments, three hybrids, viz, SFH310, SFH313 and SFH341 performed better than Hysun-33 and other genotypes. Stability was estimated using the Eberhart and Russell (1966) method. Stability analysis identified SFH310, SFH313 and SFH341 as the most stable hybrids for seed and oil yields, respectively since their regression coefficient were almost the unity (b_i=1) and they had one of the lowest deviation from regression (S^{-2}_{di}). In contrast, hybrids such as SFH32 and SFH37 with regression coefficients greater than one were regarded as sensitive to environment changes for seed and oil yields. The three promising hybrids were released later on for commercial production.

Key words: Sunflower, *Helianthus annuus*, GxE interaction, stability parameters,

PART V: CROP PRODUCTION (MANAGEMENT, PHYSIOLOGY, WEEDS, SEED AND OIL QUALITY)

IDENTIFICATION OF RUST (*Puccinia helianthi* Schw.) RACES OF SUNFLOWER (*Helianthus annuus* L.) IN TURKEY

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Sunflower (*Helianthus annuus* L.) is one of the major and valuable oilseed crops with its high oil quality in the world. Sunflower rust incited by *Puccinia helianthi* Schw. is one of the considerable foliar diseases of sunflower. The pathogen is present wherever sunflower is grown in the world and causes important yield losses when severe epidemic occurs. The objective of this study was to identify the races of sunflower rust under field condition at main and second crop production seasons. Experiments were conducted from 1991 to 2009 in Menemen - Izmir, Turkey. Race identification of *P. helianthi* was accomplished in the field conditions in which seedlings of differential lines were naturally inoculated. Twenty-three differential genotypes were used to identify races of *P. helianthi*. Sunflower rust reaction of the differential genotypes were scored on a scale of 0 to 4, where 0 to 2 = resistant, 3 and 4 = susceptible. Race 1, 3 and a new race or combination of races of *P.helianthi*, causal agent of sunflower rust, was identified in Menemen - Izmir, Turkey.

Keywords: Sunflower rust, *Puccinia helianthi*, *Helianthus* spp., sunflower, rust races.

PERFORMANCE OF SOME OILSEED AND CONFECTIONARY TYPE SUNFLOWER (*Helianthus annuus* L.) VARIETIES IN AEGEAN REGION OF TURKEY

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Vegetable oils and fats are vital components of human diet because they are an important source of energy. According to production data, sunflower was grown on 577958 ha area and 992000 metric tons of seeds were harvested in Turkey in 2008 (FAO, 2010). Because of the gap in vegetable oil production in Turkey, it is one of the alternative and leading oilseed crops to increase vegetable oil production. Growing sunflower as a crop in Aegean Region is one of the possibility to increase the production. The main objectives of this study were to determine oilseed hybrids and open polinated confectionary varieties which could be grown with satisfactory yield performance in Aegean region. The experiments including oilseed and confectionary type of cultivars were conducted separately at main crop growing seasons in 2008 and 2009 on the experiment field of Aegean Agricultural Research Institute in Menemen, Izmir. The experiments were established in randomized complete block design with four replications. As a material, oilseed hybrids and open pollinated confectionary sunflower candidate varieties were used in this study. Adaptation study were undertaken for the characters seed yield, seed oil content (%), 1000 seed weight, plant height, head diameter, seed length, seed width, hull percentage (%), seed color (white, black, and intermediate), days to flowering and days to physiological maturity. Results showed that statistically significant differences were found among the sunflower varieties for the characters in question. In the oilseed variety experiments; the highest seed yield in oil types (572 kg da^{-1}) and the lowest seed yield (343 kg da^{-1}) were obtained from the varieties ETAE-Y-TM-2007-5 and Armada in 2009 growing season respectively. While the highest seed yield in the confectionary varieties (563 kg da^{-1}) and the lowest seed yield (202 kg da^{-1}) were obtained from the varieties ETAE-D1-2-B2 and ETAE-Ç-P-1-2 in 2009 growing season respectively, in confectionary variety experiments.

Keywords: Sunflower, *Helianthus annuus* L, breeding, hybrid variety, open pollinated variety, agronomy, adaptation, yield components.

RESPONSE OF SOME WILD SPECIES OF *HELIANTHUS* TO DROUGHT AT SEEDLING GROWTH STAGE

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Response of six wild sunflower genotype / *Helianthus petiolaris spp. petiolaris* (E-142), *Helianthus neglectus* (E-017) and four *Helianthus annuus* (E-060, E-173, E-174 ve E-175) to drought stress imposed at seedling growth stage was investigated *in vivo*. Plant height, number of leaves per plant, shoot fresh weight, root fresh weight, shoot dry weight and root dry weight were determined. Results indicated that E-175 genotype belonging to *Helianthus annuus* was less affected by water stress conditions than the other genotypes. *Helianthus petiolaris spp. petiolaris* (E-142) showed the highest sensitivity, and had the lowest fresh and dry masses under drought conditions.

Key words: *Helianthus, H. petiolaris, H. neglectus, H. annuus*, drought.

THE EFFECTS OF LEAF REMOVAL ON GRAIN YIELD AND YIELD COMPONENTS OF SUNFLOWER , VAR. ALESTAR.

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To investigate the effects of leaf removal on yield and yield components of sunflower, var. alestar an experiment was conducted in green house of Gorgan University in randomized complete design with three replications in 2004. The leaf removal was done at the stage of 3.1 (one of head). The treatments at four level were: control (without leaf removal), removal of half of two leaves immediately below head, removal of full two leaves immediately below head and removal of all leaves of 20 cm of stem below the head. The measured characteristics were: number of seeds per head, head diameter, weight of one thousand seeds and grain yield. Results showed that the removal of half of two leaves immediately under head did not affect the seed number per head but it had effected on the head diameter, weight of thousand seeds and grain yield. The leaf removal in 20 cm of stem below head had the least value of measured characters that shows the removal of middle leaves on stem play an important role in seed filling and photosynthesis.

Key words: Sunflower, leaf removal, grain yield, yield components.

A LESSON FOR SUNFLOWER: THE SOYBEAN EXPERIENCE OF THE BLACK SEA REGION

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Oilseeds are one of the most valuable crops in Turkey's agriculture and economy as the most important source of vegetable oil, feed for livestock and recently biodiesel as well as feedstock. Turkey now cannot cover its own demand for oilseeds and this problem arises mainly from a lack of planning at the production phase. At the present time, more than half of the oil need is supplied by import and the import value for crude oil and oilseed crops holds the second largest figure in the country's total exchange expenditures, trailing only petroleum products. In the last two decades, although the total oilseeds production has increased nearly 20%, the area planted for oilseeds has gone down 12%. Among the oilseeds, soybean has suffered the most enormous tragedy; facing with 80% and 68% reductions in planted area and production, respectively. In the Black Sea region including Samsun and Ordu provinces, once Turkey's the most important soybean producer, soybean area and production have also decreased drastically. Soybean area and production in Samsun province have fallen down 60% and 18%, respectively. Worse still, in Ordu province where the country's first soybean oil factory was set up in 1965, soybean is not grown anymore. Farmers in the two provinces have started gravitating toward mostly hazelnut production, resulting in a nine-fold and a two-fold increase in Samsun and in Ordu provinces, respectively. Sunflower, the major oilseed crop of Turkey, currently provides approximately 50% of the country's total oilseed supply. Nevertheless, sunflower production in Turkey has followed an ever-fluctuating course over the years. The situation is even worse in Central Black Sea region including Samsun, Çorum and Amasya provinces where sunflower area has decreased 54%, 53% and 72%, respectively. On the other hand, self-sufficiency ratio in sunflower consumption has fallen down from 70% in 2000 to 38% in 2007. These excessive decreases, signaling an alarm bell for sunflower, must be seriously taken into account without delay if the country does not want to see the same tragedy again as in the case of soybean. It should always be kept in mind that strategic planning for future in most cases depends on past history.

Key Words: Oil consumption, oilseeds, production planning, sunflower.

EFFECT OF POTASIUM, SULFUR, MAGNESUM, IRON, BORON AND ZINC ON YIELD AND OIL CONTENT OF TWO CULTIVAR OF SUNFLOWER IN GONBAD

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Bearing in mind that over ninety percent of our country's edible oil consumption is imported; it is necessary that a great number of applied researches be carried out to achieve methods of increasing yield of oil seed crops in general and sunflower in particular. The great adaptability of sunflower, its resistance to drought, short period of growth (85 – 110 days) and the possibility of planting it as a second crop after wheat and barley make the research on sunflower of great importance. Since nutritional elements are one of the essential factors in yield increase, the effects of N, P, K, Mg, S and trace elements (Zn, Fe, B) on yield and seed quality of sunflower (Golsheed and Record) were investigated. The experiment was carried out with nine fertilizer treatments and two varieties of sunflowers (Golsheed and Record) in a RCBD arranged in a split-plot with three replications at the Agric. Exp. Station of Gonbad in 2000 and 2001. Before planting, a compound soil sample from the experiment site was taken. The chemical characteristics were used as follow: Fe ava=2.6, Zn ava=0.6, K ava=350, B ava=2mg kg^{-1}, OC=1.46%, TNV=20 % and pH=8.1. Based on the results, the following treatments were selected: 1–Common adopted dosages by local farmers (NP), 2-NPS, 3-NPK, 4-NPKMg, 5-NPKMgZn, 6–NPKMgFe, 7–NPKMgB 8-NPKMgZnFe, 9–NPKMgZnB. N from urea, P from triple super phosphate, K from potassium sulfate were applied at 100and 150 kg ha^{-1}, respectively. Fe from seqostrene 138, S and MgS2O4 were applied at 15, 50 and 75 kg ha^{-1}, respectively. Spraying of Zinc sulfate and borate at the rate of 0.003 and 0.015 were applied at three stages, respectively; one week before anthesis and with 15 days interval. After harvesting, seed and oil yield, protein content and the content of nutritional elements of the leaves (the forth leaf from the top at flowering) and of the seed were determined using the common laboratory procedures. Results revealed that there is a significant difference ($p = 0.01$) between two varieties for seed yield in the first year. In 2^{nd} year the 5^{th} treatment (NPKMgZn) and first treatment (common adopted dosage by local farmers) had the highest and the lowest yield, respectively. Considering little variation of oil content, the oil yield was attributed to seed yield. The effect of fertilizer treatment on the number of grain per head was significant and the fifth treatment (NPKMgZn) had the highest number of grain per head. Year by variety interaction was significant for plant height. Effect of year by fertilizer interaction on seed yield was significant. These results revealed the suitable climatic conditions of 2^{nd} year. Treatment five (NPKMgZn) had the highest seed yield.

Key words: Sunflower, varieties, yield, fertilizer.

THE INFLUENCE OF MORPHOPHYSIOLOGICAL TRAITS ON THE SEED YIELD AND OIL CONTENT OF SUNFLOWER

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Path coefficient analysis was used to separate direct and indirect effects of studied traits on seed oil content and seed yield, and to identify traits that could be used as selection criteria in sunflower breeding. Among the largest number of examined traits, significant and highly significant correlations were found. A negative highly significant interdependence has been established between stem diameter, total leaf area per plant, head diameter, the weight of 1,000 seeds with seed oil content. A positive highly significant interdependence has been established between the seed yield and stem diameter, total leaf area per plant, head diameter, total number of seeds per head, and the weight of 1,000 seeds. The weight of 1,000 seeds had high significant negative direct effect on seed oil content and high significant direct positive effect on seed yield. Total number of seeds per head has demonstrated a high significant direct positive effect on seed oil content and seed yield. Total leaf number per plant as demonstrated a significant direct positive effect on seed yield. Path coefficient analysis for seed yield at phenotypic level showed that the direct effect was maximum for weight of 1,000 seeds followed by total number of seeds per head and total leaf number per plant. Total number of seeds per head was the most important traits for seed oil content and seed yield. These results can be used in sunflower breeding programs for the creation of new sunflower hybrids with high genetic potential for seed yield and seed oil content.

Key words: *Helianthus annuus*, hybrid, morpho-physiological traits, interdependence, seed yield, oil content.

THE EFFECTIVENESS OF FORMULATIONS, BASED ON PHYTOHIT AGAINST SUNFLOWER PHOMOPSIS

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Recently, despite of growing use of disease-resistant cultivars and fungicides, the tendency to increased harvest losses of crops majority has been taken place. One of the reasons is that cultivated plants cannot fully implement their genetic potential of resistance and productivity under stress conditions, but the use of chemical pesticides sets up a great number of ecotoxicological problems. Evidently, the most ecological method of plant protection against diseases is formation and application of resistant cultivars. However, the resistance genes will be very quickly overcome by the pathogens. The sensitivity of agricultural crops to pathogens may be changed without use of selected-genetic methods. Such increase of resistance without changing of genome structure is called induced resistance. Scientific research, conducted in this direction, have led to the development of new immunity inductors to diseases including Immunocytophit, Bion, Chitosan, Phytohit, which are now used in Russia. Plant resistance induction to pathogens is implemented by means of seeds or vegetative plants pre-sowing treatment with these or others agents possessing immunopotentiating activity. The aim of our research was the identification of biological and economical efficiency of the formulations based on Phytohit against Diaporte (*Phomopsis helianthi* Munt.-Cvet et.al.). The formulations prepared on basis of Phytohit (that includes Chitosan, indoleacetic acid and phloroxan in a ratio of 80:1.2:0.2 and biostimulants Albit, Megafol, Radipharm, Actiwave and Kendal. The formations rate of application is 0.2 и 0.1 l/t. As standard the fungicide Maxim is used with an application of 5 l/t. The seed treatment was conducted a day and a night before sowing. The test version was non-treated seeds. The formulations biological and economical efficiency evaluation was conducted in the field test (2009) on sunflower Rodnik cultivar (P-453) and Master. Monitoring carried out in the period of heads formation and maturation indicated leaf and stem *Phomopsis* availability. As for test version, *Phomopsis* development on Rodnik cultivar was 18.5 %, on Master cultivar-10%. The analyses results showed that the protective effect of the formulations based on Phytohit with Albit and Kendal was from 60 to 100% (against this background of Phomopsis development). Compared with the test version, the crop yield was at the average 3.5-4.6 center/ha higher. The biological and economical efficiency of other formulations was not of such significance.

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RECENT EVALUATION OF NEW SUNFLOWER GENOTYPES FOR ADAPTABILITY IN UGANDA

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Sunflower has become the most important oilseed crop in Uganda especially in the eastern and northern parts of the country. The area under production has increased from the mid 1990s up to present. It gained popularity among farmers on account of its high oil quality and fair modest production requirements. Despite the increasing production of sunflower in the country, the yield remains low at farmers' level. The main constraints that have caused low yields in the country are lack of high yielding varieties/hybrids and poor agronomic practices. Sunflower evaluation trials were undertaken in four multilocational sites that included Serere, Kumi, Kuju and Ngetta in 2008 and 2009. The objective of the trials was to evaluate locally developed sunflower hybrids and imported hybrids for their adaptability in Uganda. In 2008, twenty seven genotypes were evaluated and in 2009, twenty five genotypes were evaluated. Each plot had four rows spacing at 75 x 30 cm and four meters long replicated three times. In 2008, the best overall mean yield was 1296 kg/ha and was obtained in Serere with the genotype PAN7033 recording the highest yield of 1833 kg/ha. Although Ngetta site had the lowest overall mean yield of 770 kg/ha, the best yielding genotype across location was from Ngetta with 1944 kg/ha, named PAN7033. In 2009, Kuju had the highest overall mean of 1426 kg/ha with the genotype PAN7033 recording 3361 kg/ha. Kumi had the lowest overall mean yield of 352 kg/ha. The oil content analyzed showed that a number of genotypes had oil content above 40%. PAN7369 had the highest oil content of 46.9%. A number of genotypes are therefore being considered for possible commercial production.

Key words: Comparative yield, hybrid development, local developed hybrids.

DETERMINATION OF POTENTIAL SUNFLOWER (*HELIANTHUS ANNUUS* L.) CULTIVARS UNDER IRRIGATED CONDITIONS IN DIYARBAKIR

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The study was conducted to determine the potential of sunflower cultivars under irrigated conditions in 2009,in the experiment field of the South East Anatolian Agricultural Research Institute in Diyarbakır, Turkey. Sanay, P-4223, Alhaca, Pactol, Armada, Sirena, C-70165, Tunca, Isera, Tarsan-1018 and TR-3080 commercial sunflower hybrids were tested in the experiments. Some important characters such as plant height, head diameter, 1000-seed weight, seed yield, and oil content also were investigated in the study. Statistically significant differences were observed among cultivars for the 1000-seed weight, seed yield and oil content at probability level a probability of 5 %. The highest seed yield per ha (4117.6 kg ha^{-1}) was obtained from Pioneer-4223 and the lowest seed yield was obtained from TR-3080 per ha with a yield of 1796.6 kg ha^{-1}, the highest oil content (40.16%) was obtained by Armada. The lowest oil percentage was obtained from Pioneer-4223 with 34.40%. The highest 1000-seed weight was measured for Isera with 83.75 g, and the lowest weight was observed in Armada with 56.11 g. In addition, the highest plant height was obtained from C-70165 with 249.96 cm and the lowest one was obtained from TR-3080 with 181.43 cm. On the other hand, the highest head diameter was obtained from Tunca with 17.46 cm, and the lowest one was measured for Armada with 13.93 cm. Research results indicated that Pioneer-4223, Pactol, Isera, C-70165, Tarsan-1018 and Armada cultivars can be recommended as potential hybrids for the region based on their seed yields and the other important characters investigated under irrigated conditions in Diyarbakır.

Key Words: Sunflower, cultivar, seed yield, adaptation, oil content.

SYNTHETHIS AND SCREENING OF HERBICIDE ANTIDOTES

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The development of means to reduce the negative effects of herbicides on cultivated plants is highly interesting topic. There is a vast patent material concerning combined usage of herbicides and antidotes with the purpose to reduce the undesirable phytotoxicity for many cultures. Unfortunately, the problem, concerning the development of means of plants vegetative protection in cases of the phytotoxicant transfer on them is completely unsolved. Our pioneer research has shown the possibility of 2,4-D phytotoxicity reduction for sunflower. For this purpose the synthesis and screening of connections, able to reduce the slaughter of culture crops, are conducted. As it is known, the search for the novel biologically active compounds is always labour-intensive. Despite of the development and upgrading of computer models and calculation methods of biological activity, the screening of novel biologically active compounds remains mainly empiric and accidental. It is impossible to predict one or another type of activity of newly synthesized compound a priori; therefore all the novel compounds go through the screening system. The research was conducted on the sunflower germs using original technique, developed in the ARRIBPP and presupposes the application of the following variants: 1. Control (water); 2. Standard (2,4-D); 3. Herbicide +antidote. In the field experiments, the sunflower plants in the most sensitive phase (10-16 leaves) are treated 2,4-D in doses, providing 40-60 % yield reduction. In a day, the plants are applied with the antidotes in the doses 100; 200; 500 g/ha. Antidote activity is estimated in regard to the yield increase of sunflower seeds in the variant herbicide + antidote in comparison with the standard. As expected, pyridine derivatives and pyridine-carboxylic acids are of the greatest interest. As result of the screening, compounds, reducing 2,4-D negative effects by 30-50% were found. Over 400 novel compounds were synthesized to develop the new scientific concept, concerning the formation of means and methods to reduce the herbicide negative effect on the sensitive crops. Over 20 patents were obtained. In the field of plant ecologization, the scientific and methodological base for the wide screening of new antidotes was created and the development of technologies to reduce the negative effect of herbicide application, that on the whole lessens the real threat for the agrophytocenosis.

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A RESEARCH ON DETERMINATION YIELD AND YIELD COMPONENTS OF SOME OIL SUNFLOWER (HELIANTHUS ANNUUS L.) TYPE AND LINES UNDER CUKUROVA CONDITIONS

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The research was performed to determine the yield and yield characters of oil type sunflower hybrids in Cukurova conditions. The experiments were conducted as randomized complete blocks with three replications in TİGEM Farm Ceyhan. Some of the characters related to yield such as the number of days to flowering, the plant height, the head diameter, the weight of 1000 seed, the seed yield, ratio of oil and oil yield were examined in the experiments. The highest seed yield (4417.7 kg ha^{-1}) was obtained from Alhaja and the lowest seed yield (2955.4 kg ha^{-1}) was obtained from Sirena commercial hybrid. The highest oil percentage (44.0 %) was measured in 04TR165 experimental hybrid and the lowest oil percentage (26.50 %) was observed in 03TR233 experimental hybrid. Through the mutual relationship between the characters, which were examined, a positive and significant correlation was found between yield of seed and the head diameter (r=0.3152), significant but a negative way correlation was found between the yield of seed and the plant height (r=-0.1861). The significant and positive correlation was determined between the number of days to flowering and the plant height (r=0.3037) and significant but negative relation was determined between the weight of the 1000 seed (r=-0.2965) and the head diameter (r=-0.1024).

Key words: Oil type sunflower, plant height, head diameter, 1000 seed weight, oil content, days to flowering, correlation analysis.

THE DETERMINATION OF ADAPTATION CAPABILITIES OF SOME OIL TYPE SUNFLOWER *(HELIANTHUS ANNUUS* L.) HYBRIDS IN KAHRAMANMARAS CONDITIONS

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The research was conducted to determine the yield and yield characters of ten different oil type sunflower experimental hybrids received from Trakya Agricultural Research Institute and also some commercial hybrids in Kahramanmaraş conditions. The field experiments was laid out as randomized complete blocks with three replications in the experiment field of Kahramanmaras Agricultural Research Institute, during the 2008 and 2009 growing seasons. In the experiment, some of the characters related to yield such as the number of days to flowering, the plant height, the head diameter, the weight of 1000 seeds, the seed yield, ratio of oil and oil yield were examined. Based on two year data, the highest seed yield (298.5 kg/da) and oil yield (128.6 kg/da) were determined for Sanbro commercial hybrid, whereas the highest oil percentage (%45.5) was measured for 6388"A" X 63462-R line and the highest plant height 173.8 cm) was found for 64A14 commercial hybrid.

Key words: Oil type sunflower, adaptation, oil yield, seed yield, hybrid

RESIDUAL EFFECTS OF SPRAYING IMIDAZOLINONE FAMILY HERBICIDES ON CLEARFIELD® SUNFLOWER PRODUCTION IN TERMS OF CROP ROTATION

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This research was carried out to determine the soil residual effects on rotation crops winter soft wheat (*Triticum aestivum* L.), barley (*Hordeum vulgare* L.), winter oilseed rape (WOSR) (*Brasscica napus* L.), maize (*Zea Mays* L.) and sugar beet (*Beta vulgaris* L.) stand establishment rate and yield after INTERVIX® (33 g Imazamox + 15 g Imazapyr) spraying in CLEARFIELD® (CL) sunflower (*Helianthus annuus* L) production field. The experiments were conducted at Trakya Agricultural Research Institute in Edirne between 2007 and 2009 using randomized Complete Block Design (stripe plots) with three replications. Five crops were evaluated on crop rotation after spraying INTERVIX® in CLEARFIELD® sunflower. As the experiment materials Sanay-CL sunflower hybrid, Gelibolu-soft winter wheat, Bolayır-barley, Elvis-WOSR, Brasco-maize and Leyla sugar beet varieties were planted in the plots. Nitrogen and phosphorus fertilization were applied according to soil analyzes recommendations. Observations such as number of plants emerged per m^2, stand establishment, yield, time to flowering, time to physiological maturity, plant height, root length, head diameter etc. were taken according to plants included in crop rotations. Based on the statistical analysis of the data from crop rotation experiments, CL sunflower plots followed by wheat, barley, and maize were not affected significantly by INTERVIX® residue in terms of stand establishment rates and seed yield in both years. But in the first year of crop rotation, when planting WOSR after four months from INTERVIX® application on CL sunflower plots, the rate of stand establishment and seed yield decreased significantly by 35.7 and 23.7 %, respectively. The parallel results obtained when planting sugar beet after nine months from INTERVIX® application on CL sunflower plots, the stand establishment and beet yield decreased by 26.7 and 11.6 %, respectively. However, in the second year in the same crops rotations plots, stand establishment and yield of WOSR and sugar beet planted after CL sunflower were not affected significantly by INTERVIX® residue.

Key words: Imidazolinone, CLEARFIELD sunflower, wheat, barley, WOSR, maize, sugar beet, stand establishment.

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CURRENT STATUS OF SUNFLOWER CROP IN GREECE AND THE EFFECTS OF *OROBANCHE CUMANA* INFESTATION

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Sunflower constitutes a potential crop in Greece and especially in the prefecture of Evros (North East Greece), due to the constant increase of the demand from the food and the biofuel industry. The need for higher and permanent yield and therefore the sustainability of the crop followed by the need for a lower cultivating cost, demand a more efficient weed management. The most significant constraint for sunflower production in this region is the broomrape species, *Orobanche cumana*. Even if the farmers select *Orobanche* tolerant hybrids, the holoparasite's presence remains a problem. As a result, the mapping of *O. cumana's* spatial distribution, its different races and also the amplitude of the problem is crucial for the farmers, the breeders and the agronomists working in Greece. The crop is included in a rotation system primarily with grain and secondly with corn. However, the usual practice is monoculture. The weed management is conducted mainly by herbicide treatments such as Treflan (trifluralin), Granstar (tribenuron methyl) and Oxyfluorfen (oxyfluorfen). During 2008-2009 period there was a great demand and preference for "Clearfield" (Imazamox-resistant) sunflower in order to tackle E and F races. Intensive surveys were conducted in 20 different areas during summer of 2009, where previous information on heavy broomrape infection existed. The sampling procedure was accomplished by following a zigzag pattern in 5 random locations in each field. The results were extremely encouraging for the Imazamox-resistant sunflower technology, since zero broomrape infection was observed in previously heavily contaminated areas. However, the problem existed for E and F race resistant varieties in some cases. The infestation rate was low (approximately 2 broomrape stalks per 10 sunflower plants) for F race resistant varieties, while the rate was high (approximately 5 broomrape stalk per sunflower plant) for E race resistant varieties. Additionally, this preliminary survey outlined the steps for the development of a baseline guide addressed to the local agronomists and farmers in order to limit the *Orobanche* occurrence in the sunflower crop and posed the need for further research in the area.

EFFECTS OF NITROGEN AND PLANT DENSITY ON DWARF SUNFLOWER HYBRIDS

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This research was carried out to determine the seed yield and some yield components of two dwarf hybrids compared with one standard height sunflower hybrid (*Helianthus annuus* L.) at different nitrogen rates and planting densities under natural rain fed conditions at the Thrace Agricultural Research Institute in Edirne-Turkey between 1999 and 2001. The experiments were set up in split-split plots in randomized Complete Block Design with three replications. Main plot treatments were three different height sunflower hybrids, TR-DW-1, TR-DW-2, and Trakya-80. The sub plots were three levels of nitrogen, 0, 60, and 120 kg N/ha. The sub-sub plots were three planting densities, 10X70 (142.850 plant/ha), 15X70 (95.230 plant/ha), and 20x70cm (71.430 plant/ha). Observations were taken on seed yield, oil content, oil yield, 1000 seed weight, test weight, seed hull rate, plant height, head diameter, time to flowering, and time to physiological maturity. Nitrogen fertilizer increased significantly seed yield, oil content, oil yield, seed hull rate and head diameter of three different height sunflower hybrids in natural rain fed conditions. Based on marginal economical analyses, optimum economical seed yield from per ha was obtained at 50 kg N/ha for TR-DW-1, 80 kg N/ha for TR-DW-2 and Trakya-80 hybrids. Increasing plant densities of three different height sunflower hybrids decreased 1000 seed weight, seed hull rate and head diameter but increased test weight in natural rain fed conditions. The highest seed yield was obtained on 15x70 cm (95.230 plant/ha) plant population for both dwarf hybrids. The results of this research show that nitrogen and plant density have significant effects on seed yield and some yield components of different height sunflower hybrids.

Key words: Sunflower, dwarf, nitrogen, plant, density.

EFFECT OF PLANTING DATE AND PLANT POPULATION ON THE OIL CONTENT AND FATTY ACID COMPOSITION IN SUNFLOWER

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Grain oil content and stability of fatty acid from sunflower seeds are very important traits for sunflower hybrids cultivated in conventional system. The research was carried to determine planting date and plant population effect on oil content and fatty acid composition, using three sunflower hybrids (Favorit, Performer, Alex) and two vegetation periods. The results revealed that oil content from sunflower seeds was very significantly affected by planting date, year, hybrid and its interactions for all plant population. Between those factors, planting date was the main source of variance for oil content (45-50%). The early planting date under both year conditions led to an increase of grain oil content in all tested sunflower hybrids and on the average for all plant population. Our results showed that the lowest plant population decreased the grain oil content as compared with high plant densities in the 2009, while in 2008, there are some exceptions; for Favorit hybrid, the oil content was not significantly affected by planting density and for Alex hybrid, the low plant density increased oil content. These contradictory results might have been due to the differences in climatic conditions. The delay in planting decreases concentration of the oleic acid and increases linoleic acid concentration in all sunflower hybrids, more obviously under drought conditions than under almost normal conditions.

Key words: Sunflower, planting date, plant population, seed yield, oil content, fatty acid composition.

EFFECT OF STORAGE PERIOD AND CHEMICAL TRATMENT ON SUNFLOWER SEED GERMINATION

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Sunflower hybrid seed is regularly treated with various pesticides for protection against pests and diseases. If this seed is not used in the first year, it will be used in a second or a third year after chemical treatment. In that case it needs to be stored and the period of keeping it in storage might have an influence on the quality of the seeds. Effects of storage period on germination were tested using the standard ISTA method. The experiment included three commercial hybrids and four different chemical treatments. On average, hybrid Sremac had the highest (94.61%), and hybrid Šumadinac had the lowest seed germination (90.29 %). After one year of storage seed germination of all hybrids declined significantly. Higher values of germination were observed for all three hybrids treated with fungicides and the control, compared with seeds treated with a combination of fungicides and insecticides. However, this was not found when seeds were tested immediately after treatment.

Key words: Sunflower seed, germination, storage duration, chemical treatment.

BROOMRAPE (*OROBANCHE CUMANA* WALLR.) IN ROMANIA - DISTRIBUTION AND RACE COMPOSITION

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Broomrape (*Orobanche cumana* Wallr.) is the most important problem in the sunflower crop in southern and southeastern Romania. It leads to considerable losses yield and lower seed quality in seed. Furthermore, the parasite forms new and more virulent races, which overcome the resistant hybrids commonly used in production. With a view of limitting the parasite's distribution and decreasing the losses it causes, it is well to know the distribution area of the parasite races and the rate and percent of the broomrape attack. The sunflower crop acreage in southern and southeastern Romania was divided in 5 large areas, where the presence and intensity of broomrape races in sunflower fields was evaluated in the years 2007, 2008 and 2009. In one of these areas (Teleorman), the race F was not found, only race E, as the most virulent, was present. In one area (Braila), the progress of infestation and dispersion with race F showed a slow advance. In Lalomita area, the presence of race F accounted for 65%, without causing serious damage to the sunflower yield. In the Tulcea and Constanta areas, race F infestation was very high, being identified as a new more virulent broomrape population, overcoming race F.

Key words: Sunflower, broomrape, races, distribution, infested areas.

MICRONUTRIENT CONTENTS IN LEAVES OF SUNFLOWER CULTIVARS GROWN WITH DIFFERENT BORON DOSES

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Although boron is essential for crop growth, the amount required differs among plant species. Sunflower (*Helianthus annuus* L.) requires greater quantities of boron to satisfy its metabolic needs than other cultivated species. The present work was undertaken to evaluate the effects of five boron doses of 0, 2.5, 5.0, 7.5 and 10.0 kg B ha^{-1} (as spray of boric acid, H_3BO_3) in B-deficient calcareous soils (0.19 B mg kg^{-1}) on micronutrient contents in leaves of four sunflower cultivars during 2001 growing season. Boron (B), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) concentrations were measured in sunflower leaves at the stage of flowering. According to the results, cultivars have shown variations with respect to their responses to B applications. Fe, Mn, B, Cu and Zn concentrations in the leaves were not changed by the different B levels, however, leaf Mn, B and Cu concentrations varied with the cultivars. Among the cultivars, TR-4098 had the highest Mn (90.74 mg kg^{-1}) and Cu (45.94 mg kg^{-1}), while AS-615 had the highest B (176.1 mg kg^{-1}) concentrations.

Key words: Boron, sunflower, cultivar, micronutrients.

EFFECT OF DIFFERENT DOSES OF NITROGEN ON THE YIELD AND YIELD COMPONENTS OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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This study was conducted with Biser sunflower variety in Edirne ecological conditions in 2008. The split-plot designs-random models with 3 replications were utilized. As the nitrogen fertilizer the ammonium sulfate, calcium ammonium nitrate and urea were used. Nitrogen doses are N_0: 0, N_1: 5, N_2:10, N_3: 15 and N_4: 20 kg/da. In this study, plant height, 1000 seed weight, seed yield and oil content were investigated. The tallest plant height was obtained with ammonium sulfate (N_3:101.22 cm). The highest 100 seed weight and seed yield were obtained with calcium ammonium nitrate (N_3: 34.85gr-213.01 kg/da). The highest oil content was obtained with calcium ammonium nitrate (N_3: 44.43 %). The most favorable fertilizer was found as calcium ammonium nitrate in terms of 1000 seed weight, seed yield and oil content.

Keywords: Sunflower, nitrogen fertilizer, nitrogen doses, oil content

SPRING VS. WINTER SOWN PERFORMANCE OF SUNFLOWER CULTIVARS UNDER RAINFED CONDITIONS

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In order to evaluate winter planting possibility of resistant oilseed sunflower cultivars under rainfed conditions of Golestan, Iran which may help utilize precipitation efficiency and mitigate terminal stage heat and drought damages, an experiment was conducted at Gonbad agricultural research station in years (2003-2006). The experiment was a split-plot arranged in an RCBD with four replications. Four planting dates (Dec 20th, Jan 20th, Feb 20th and March 20th) and 4 cultivars (Azargol, Gabor, Progress and Zaria) were levels of main and sub-plots, respectively. Common note-takings consisted of phenologic stages, yield and its related traits were done. Data obtained were analyzed each year and after 3rd year, combined analysis of variance on evaluated traits was done using F-test. All traits with the exception of oil percentage and yield were significantly affected by year. Difference of planting dates was significant for stem diameter, growth duration, 1000 seed weight and seed yield. First and last planting date had the highest (1.898) and lowest (1.305 t/ha) seed yield, respectively. Delay in planting date resulted in a decrease in yield and its related traits. There were significant differences between cultivars for all traits with the exception of head diameter, oil content and oil yield. Year by planting date interaction was significant for plant height, growth duration, 1000 seed weight and yield which could be attributed to very cold winter in the second year (2004-2005) of experiment. Cultivar had significant effect on all traits with the exception of head diameter, oil content and yield. Gabor and Zaria had the highest (1.849t/ha) and lowest (1.539 t/ha) seed yield, respectively. Three year means indicated that Gabor and Zaria performed well at 1st planting date(Dec 20th) whereas Azargol and Progress had their best performance at 3rd planting date(Feb 20th).

Key words : Sunflower, winter planting, yield, 1000 seed weight

THE EFFECT OF DIFFERENT ROASTING TECHNIQUES ON PHYSICAL AND CHEMICAL PROPERTIES OF SUNFLOWER SEED OIL

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The oil seed and oils of sunflower seeds were carried out for a comparative results on their physico-chemical and nutritional value. Physico-chemical characteristics were determined using the methods of the American Oil Chemists Society. Seeds were evaluated for oil, protein, crude ash and crude fibre. Refraxtive index, relative density, unsaponifiable matter and peroxide values were determined in the seed oils. The main fatty acids identified by gas chromatography were palmitic, oleic and linoleic acids. Also, tocopherol contents were determined depending on roasting effect.

Key words: Sunflower, roasting, fatty acid, tocopherol.

SUNFLOWER STEM CANKER (*PHOMOPSIS HELIANTHI)* PROGNOSIS IN SUNFLOWER CROPS

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Stem canker induced by *Diaporthe helianthi* Munt.Cvet.et al.(f. c.*Phomopsis helianthi*) has been one of the most damaging disease of sunflower crop in Romania. Within the modern protection technology of sunflower crops, the chemical control of pathogens is still an important way to obtain quantitatively and qualitatively good yields. The paper presents a modern method for the protection of sunflower culture against the *Phomopsis helianthi* attack. The chemical treatment application in vegetation, at ecological advertising, reduces the number of chemical treatments and results in a maximal fungicide efficiency, a good quality of the harvest and reduced environment pollution. In order to control the *Phomopsis helianthi* attack in sunflower, 11 systemic fungicides were tested in this study.

SUNFLOWER BIOMASS AND SEED YIELD IN SALINE SOIL OF MEXICO HIGHLANDS

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Soil salinity is a worldwide problem. In Mexico, it is located particularly in arid and semiarid regions of centre and north of the country. The study was carried out in saline soils of Montecillo Mex. (19 º N, 48 º W and 2,400 m), of arid climate (the less dry), average annual rainfall of 558.5 mm and average temperature of 14.6 º C. Its natural vegetation is halophyte emphasizing the salt grass (*Distichlis spicata* L.) and "romerito" (*Suaeda nigra* L.), and also there is rainfed agriculture and to a lesser degree irrigation agriculture, where maize is grown alone or in association with beans or squash but both agrosystems with low yield. To increase the yield on this soil, sulphuric acid and gypsum are applied, however, these methods, when applied in big areas are costly. The use of plant species to improve saline soils is a sustainable and economic alternative, because these species, besides reducing salinity produce seeds and biomass for human consumption and animal and provide good soil coverage, which also reduces erosion. The aim of this study was to evaluate biomass production and partition in the organs of sunflower under a gradient of salinity and sodium in the soil. The Victoria sunflower was sown on 15 June 2007, to the density of 100 thousand plants ha^{-1}. Based on the analysis of soil (6 samples from each repetition, to 30 cm depth of the profile before sowing) three areas of 100 m^2 considered as: high salinity (pH 7.3, EC 5.7 dS m^{-1}, Na + interchangeable 1.6 cmol kg^{-1},HS), medium (pH 7.8, EC 7 dS m^{-1}, Na + 3.0 cmol kg^{-1},MS) and low (pH 8, EC 11 dS m^{-1}, Na + 9.5 cmol kg^{-1} ,LS). Each area was subdivided into 4 plots (replicates) of 25 m^2. The plants of 4 m^2 in each plot were harvested to record: survival (%) (number of plants emerged/ density of population * 100), seed yield (g m^{-2}) and total biomass (g m^{-2}) and its distribution in organs of the sunflower. Crop emergence occurred at 8 days after sowing (DAS), the initiation of flowering (R5) at 80 DAS and physiological maturity (R9) at 130 DAS. Survival, biomass and yield of sunflower decreased in relation to salinity content in the soil. Biomass and higher seed yield was 1055 and 102 g m^{-2} in LS , and the lowest of 312 and 29 gm^{-2} for HS, respectively. The greatest dry matter accumulation was observed in the stem, followed by the receptacle , seeds and leaves , 56%, 25%, 10% and 9% respectively of the total biomass, harvest index and filled capitullum index were not affected by salinity. We conclude that the survival, biomass and yield of sunflower decreased with increasing soil salinity and sodium. The biomass partition in the organs of the sunflower is not affected by changes in soil salinity and sodium.

THE STUDY OF GROWTH INDEX, YIELD AND YIELD COMPONENTS OF THREE SUNFLOWER GENOTYPE IN BOJNORD (IRAN) AREA

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Depending on plant physiological characteristics, climatic conditions are very different plant genotypes. Indices to growth yield and yield components in sunflower, research were carried out with 1837 genotypes at University Experimental Research Station located in Bojnourd Grmkhan. In this research, including sunflower genotypes Tuesday, Master and CMS19 were compared in a randomized complete block design with 3 replications. Among the genotypes studied physiological indicators of plant growth such as CGR, LAI significant differences were observed in 5 percent level. Having good growth indicators, the higher records were observed on the number for CGR, LAI and TDM (total dry matter), respectively. Studied genotypes of seed traits, seed weight and yield the statistical level of 5 percent had significant differences too. Record numbers observed on maximum number of seed, grain weight and grain yield, respectively. Genotype CMS19 had the minimum number of seed, grain weight and grain yield, respectively. The results gained for cultivation in record number of Bojnourd recommended.

Key words: Sunflower, physiological indices, cultivars.

PRELIMINARY IDENTIFICATION OF ROMANIAN SUNFLOWER HYBRIDS SUITABLE FOR ECOLOGICAL SYSTEM

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In order to identify sunflower hybrids with good performance under organic (ecological) agriculture system, nineteen Romanian sunflower hybrids were tested in 2009 in dryland yield trials under organic agriculture system, in three locations from South Romania: Stefan cel Mare, Stupina and Simnic. Results were compared with those obtained in a dryland yield trial at Fundulea under conventional agricultural system. The preceding crop at Fundulea, Stupina and Stefan cel Mare was winter wheat and at Simnic was alfalfa. The control of weeds was the same in all ecological farm systems. Four hybrids (H7, H13, H17 and H20) performed well in all locations and under both agriculture systems, while others gave good results only under ecological or under conventional system. Testing under different agriculture systems can be useful in identifying sunflower hybrids with broad adaptability

Key words: Sunflower, organic agriculture system, yield

DETERMINATION OF PHYSIOLOGICAL FACTORS LIMITING YIELD BY CHANGING SOURCE–SINK RELATIONSHIP IN SUNFLOWER

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A field experiment was conducted to investigate the hypothesis that yield of sunflower may be limited by potential seed size. In this investigation, the source – sink ratio was manipulated to examine the performance of source-sink interactions after pollination and the factor(s) limiting grain filling. Plants of sunflower were artificially modified to give different source – sink ratios. The treatments were different plant density including; 85, 115 and 145 thousands plant per hectare and removing of grain in capitol including; removing1/3 of grains in proximal part, removing 1/3 of grains in middle part and removing 1/3 of grains in central part of capitol. The distribution of dry matter between kernels was analyzed at harvest in all treatments. Modification of source – sink ratio led to different patterns of allocation of dry matter. The pattern of partitioning of dry matter observed in plants in this investigation suggests source limitation in sunflower. Removing of grains in capitol led to higher grain weight as compared to control plants. Grain yield showed higher level with increasing plant density and it was due to higher grain number and remobilization.

Keywords: Plant density, source, sink, manipulation, sunflower

THE DETERMINATION OF THE PERFORMANCES AND THE ADOPTION STIUATION OF SUNFLOWER CULTIVARS BASED ON THE RESISTANCE TO BROOMRAPE AT FARMER CONDITIONS IN TRAKYA REGION

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About 65% of sunflower production of Turkey, which is 11th in the world sunflower producers countries based on the FAO data, occurs in Trakya Region. The biggest problem is broomrape (*Orobanche cernua* L.) in sunflower areas in Trakya region, which has a specialized structure for sunflower production. Three types of sunflower cultivars are planted in the region and these are hybrids genetically resistant to broomrape, non resistant ones and IMI (Imidazolinone) herbicide resistant ones which control both broomrape and key weeds in sunflower production. The adoption situation and their performances of these three sunflower hybrid types were studied in the research. Firstly, plant production pattern of the farmer enterprises in the survey area was analyzed then the importance of sunflower was emphasized in the region with calculating total agricultural income and the rate of sunflower in this amount in the research. The research data was obtained from 571 farmer enterprises which determined based on "Stratified Random Sampling Method" in Trakya region. The adoption rate, degree and intensity of sunflower hybrid groups by farmers were determined. Sunflower is grown at 42% of total cultivated land which applied survey in the research and take part of 23% of total agricultural revenue. The adoption rate and degree of IMI herbicide resistant and geneticially broomrape resistant sunflower hybrids was calculated over 90%. The highest yield as 1915,10 kg ha^{-1} was obtained from genetically broomrape resistant hybrids in the research areas. Based on the research results, 38 sunflower hybrids in total were used by producers in the three types (genetically resistant to broomrape hybrids, non resistant ones and IMI herbicide resistant). The having high yielding potential and easier weed control are seen among most important factors by farmers to choose sunflower seed. The statistical differences were observed among sunflower hybrid types based on seed yield, revenue and seed amounts. The highest net profit was obtained from genetically broomrape resistant hybrids in the study. Additionally, based on the results, non resistant ones were found more profitable than IMI resistant hybrids.

Key Words: Sunflower production, broomrape, revenue, adoption, yield, farmers' perception.

FATTY ACID CHANGES AND ITS RELATIONSHIPS IN SUNFLOWER

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Sunflower ((*Helianthus annuus L.*) is one of the main crops both in Turkey also in the world. Normally sunflower is growing mainly for oil and its oil consumes mainly for cooking oil due to higher linoleic fatty acid content. In recent years, new trend as the oleic type sunflower also started in firstly in US then spread out Spain and France, but not yet much in Turkey and other Black Sea countries which have more than half of world sunflower areas and production. However, high oleic sunflower oil (over 80 %) demand has been gradually increasing in Turkey and other producer countries too year by year due to more suitable for frying, offering healthier and high quality oil for consumers. On the other hand, on the determination of fatty acid content in sunflower environmental factors play important roles especially night temperatures during the grain filling and water stress conditions. The research goal is to determine the relationships and the changes among fatty acid contents in sunflower and effects of environment. The experiments were conducted in National Sunflower Breeding Project by Trakya Institute in two locations in Edirne and Kesan in 2008 and only Edirne location in 2009. Fatty acid contents (linoleic, oleic, palmitic, stearic) of hybrids were measured utilizing from Gas Chromatography in Trakya Birlik lab. Oleic acid content of hybrids was changed between 40.5-89.2%; linoleic acid 1.5-46.1%, stearic acid between 1.6-5.6%, and palmitic between 2.9-7.0% in 2008 experiments consisting mid and high oleic type sunflower hybrids. Highly significant correlations were observed among fatty acids except stearic with oleic and stearic with palmitic acid. Linoleic by oleic, palmitic by oleic and stearic by linoleic was calculated in negative way but palmitic by linoleic in positive way observed. Similar to correlation analysis, there is a reverse linear relationship between oleic and linoleic (R^2=0.988), and oleic and palmitic acid (R^2=0.539) meaning that while oleic acid was increasing palmitic and linoleic values was decreasing linearly in 2008. On the other hand, highly linear relationship was observed between linoleic and palmitic acid in same way. Similar results were obtained in two locations both correlation and regression analysis. However, both oleic and non oleic types analyzed separately in 2009 and significant correlations observed only between oleic and linoleic acid content in both high oleic and non oleic type hybrids too. The changes between planted F1 and product seeds obtained from the fields also analyzed, there was no big differences were observed between measured four fatty acid values.

Key Words: Sunflower, oleic type hybrid, fatty acid content, oleic, linoleik, environment.

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