

BOOK OF PROCEEDINGS



*XIV International Scientific Agriculture Symposium
"Agrosym 2023"
Jahorina, October 05-08, 2023*



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**XIV International Scientific Agriculture Symposium
“AGROSYM 2023”**



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PREFACE

Dear colleagues,

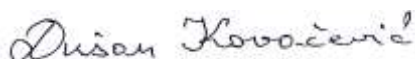
I am pleased to introduce the Book of Proceedings of the 14th International Scientific Agricultural Symposium “AGROSYM 2023”, which I hope you will find useful in your work. Almost 700 contributions have been accepted for the Book of Abstracts. The themes of AGROSYM 2023 cover all branches of agriculture and are divided into seven sessions: 1) Plant production, 2) Plant protection and food safety, 3) Organic agriculture, 4) Environmental protection and natural resources management, 5) Animal husbandry, 6) Rural development and agro-economy, and 7) Forestry and agroforestry.

Many scholars and practitioners argue that technology can increase production and feed more people while increasing supply stability and reducing the environmental impacts of agricultural production. Technology has been particularly important for improving production in annual crops such as maize, rice, soybean, wheat and cotton. Because trees have longer cycles, their breeding programs take longer. New plant breeding techniques can improve productivity, but there is a lively academic debate about their pros and cons.

While attention has been paid in the past mainly to the production side (cf. productivity, efficiency), more attention is nowadays paid to the consumption side as well as the intermediate stages (e.g. processing, distribution) of the food chain thus moving towards a ‘farm to fork’ approach. Globally, consumers are sending clearer signals about what they want on their tables i.e. higher quality as well as healthier, safer, and tastier products. Therefore, most agri-food companies have been exploring new, innovative ways to ensure more control over the production processes as well as final products quality and safety. Changes in investment strategy also have the potential to reduce the environmental and social costs of agriculture. It is now clear to most investors that companies paying more attention to sustainability and social responsibility, will have better returns on investments.

Agri-food systems have been central in the global debate on sustainable development and the achievement of the Sustainable Development Goals (SDGs) by 2030. Indeed, agri-food systems are at the center of various global challenges such as climate change, poverty, vulnerability, food insecurity, biodiversity loss, resource scarcity and ecosystem degradation. In this context, one of the goals of the sustainable agriculture movement is to develop farming systems that mitigate or eliminate environmental harms associated with industrial agriculture. It is also crucial to improve the resilience of food systems to crises, shocks and pandemics.

Many thanks to all the authors, reviewers and colleagues for their assistance in editing the Book of Abstracts. Special thanks go to all co-organizers and partners for their unselfish collaboration and comprehensive support.



East Sarajevo, 07 October 2023

Prof. Dušan Kovačević, PhD

Editor in Chief, President of the Scientific Committee of AGROSYM 2023

CONTENT

PLANT PRODUCTION	28
EFFECTS OF SOIL COVERAGE ON KIWIFRUIT (ACTINIDIA DELICIOSA CV. HAYWARD) PRODUCTION Peter A. ROUSSOS, Athanasios TSAFOUROS, Efstathios NTANOS, Nikoleta-Kleio DENAXA	29
EVALUATION OF THE TOLERANCE OF GRAPEVINE ROOTSTOCKS TO HIGH NACL SALT CONTENT IN THE SOIL, BASED ON THE CALCULATED VALUE OF THE TOLERANCE INDEX Fatbardha SHPATI	34
EFFECT OF THE COVID-19 PANDEMIC ON THE IMPORT AND EXPORT OF MINT (<i>MENTHA PIPERITA</i> L.) IN SERBIA Marija MARKOVIĆ, Milan UGRINOVIC	41
EFFECTS OF STRESS-ALLEVIATING PRODUCTS ON OLIVE PRODUCTIVITY AND OLIVE OIL QUALITY Peter A. ROUSSOS, Asimina-Georgia KARYDA, Vicky CHRISTOPOULOU	46
INFLUENCE OF BIOFERTILIZERS ON YIELD AND QUALITY OF LETTUCE GROWN IN THE OPEN FIELD Aleksandra GOVEDARICA-LUČIĆ, Dragana KNEŽEVIĆ, Dragica GAGOVIĆ, Milica GRUBAČIĆ, Milica STOJANOVIĆ	51
GROWTH PARAMETERS OF PEPPER TRANSPLANTS CULTIVATED BY THE FLOATING CONTAINERS TECHNOLOGY Elma SEFO, Zrinka KNEZOVIĆ, Lutvija KARIC	56
THE INFLUENCE OF VARIETY AND ENVIRONMENTAL CONDITIONS ON THE FORMATION OF PODS AND SEEDS AND YIELD OF FORAGE PEAS Igor ĐURĐIĆ, Vesna MILIĆ, Branka GOVEDARICA, Tanja JAKIŠIĆ, Nevena RISTIČEVIĆ, Jovana KOVAČEVIĆ, Slađana JANKOVIĆ	63
ORGANOLEPTIC, CHEMICAL AND MICROBIOLOGICAL PROPERTIES OF PEA SILAGE FROM THE JUGOVIĆ FARM Ivana BOŠKOVIĆ, Milan JUGOVIĆ, Tanja JAKIŠIĆ, Selena ČEVRIZ, Zoranka MALEŠEVIĆ	69
INFLUENCE OF CULTIVAR ON PHENOLOGICAL TRAITS, FRUIT CHARACTERISTICS AND YIELD OF PLUM Mirjana RADOVIC, Ivana MILETIC, Mirko KULINA, Dejan ZEJAK, Mihajlo LIZDEK	75
THE EFFECT OF SET SIZE AND PLANTING TIME ON THE ONION BULBS PRODUCTION Nikolina ĐEKIĆ, Milica BOSNIĆ, Vida TODOROVIĆ, Mirjana ŽABIĆ	82
THE INFLUENCE OF GENOTYPE AND AGRO-ECOLOGICAL CONDITIONS ON THE CONTENT OF STARCH IN TUBERS	

Branka GOVEDARICA, Vesna MILIC, Tanja JAKISIC, Selena CEVRIZ, Milan JUGOVIC	89
COMPARATIVE ANALYSIS OF GRAPE AND WINE QUALITY BETWEEN VRANAC AND CABERNET SAUVIGNON VARIETIES (<i>VITIS VINIFERA</i> L.)	
Tijana BANJANIN, Tatjana JOVANOVIĆ-CVETKOVIĆ, Zorica RANKOVIĆ-VASIĆ, Milenko BLESIC	94
ANALYSIS OF AGREEMENT OF RATERS DURING SENSORY ASSESSMENT OF WINES BABICA I CRLJENJAK KAŠTELANSKI	
Zrinka KNEZOVIĆ, Živko SKRAČIĆ, Danijela SKROZA, Mara BANOVIĆ	101
EFFECT OF THE COVID-19 PANDEMIC ON THE IMPORT AND EXPORT OF CHAMOMILE (<i>MATRICARIA CHAMOMILLA</i> L.) IN SERBIA	
Marija MARKOVIĆ, Milan UGRINOVIĆ	107
ARTA KIWIFRUIT: A CLONE OF HAYWARD WITH INTERESTING QUALITY CHARACTERISTICS	
Peter A. ROUSSOS, Anna KOSTA, Efthalia STATHI, Nikoleta-Kleio DENAXA, Athanasios TSAFOUROS, Efstathios NTANOS, Eleni TANI	112
COMPARATIVE EVALUATION OF SELECTION INDEXES FOR IDENTIFYING SUPERIOR WINTER BARLEY GENOTYPES	
Nikolay DYULGEROV, Boryana DYULGEROVA	118
THE IMPACT OF BIOSTIMULATOR ON WHEAT PROPERTIES: A CASE STUDY ON WELL-SUPPLIED SOIL IN THE 2021/2022 GROWING SEASON	
Dario ILJKIĆ, Marina MARINIĆ, Mirta RASTIJA, Ivana VARGA, Zvonko ZEKO, Josip STANIĆ, Luka DRENJANČEVIĆ	124
EFFECT OF DIFFERENT FERTILIZERS ON SEED GERMINATION AND DEVELOPMENT OF SEEDLINGS OF ANNUAL DAHLIA	
Marija MARKOVIĆ, Dragana SKOČAJIĆ, Danijela ĐUNISIJEVIĆ-BOJOVIĆ, Marija NEŠIĆ, Neda ORAŠANIN MILAKOVIĆ	130
EFFECT OF <i>AILANTHUS ALTISSIMA</i> ON PHOTOSYNTHETIC ACTIVITY, YIELD AND OLIVE OIL QUALITY CHARACTERISTICS UNDER TWO IRRIGATION REGIMES	
Asimina-Georgia KARYDA, Peter A. ROUSSOS	134
BIOSTIMULANTS EFFECT ON BALSAM CROP DURING ITS FIRST YEAR OF ESTABLISHMENT	
Athina TEGOU, Dimitrios BARTZIALIS, Ilias MICHALAKIS, Kyriakos D. GIANNOULIS, Nicholas G. DANALATOS, Eleni WOGIATZI	140
GROWTH AND FIBER YIELD OF HEMP UNDER DIFFERENT LEVELS OF IRRIGATION AND N-FERTILIZATION	
Ippolitos GINTSIODIS, Dimitrios BARTZIALIS, Andromachi ROUMELIOTI, Konstantina-Maria KOTSARINI, Natalia-Maria METAXA, Stylianos GIANNOULIS, Kyriakos D. GIANNOULIS, Nicholas G. DANALATOS	145
IRRIGATION AND FERTILIZATION EFFECT ON THE GROWTH OF A 2009 ESTABLISHED PERENNIAL CARDOON CROP	

Dimitrios BARTZIALIS, Ippolitos GINTSIODIS, Kyriakos D. GIANNOULIS, Nicholaos G. DANALATOS.....	150
EFFECT OF IRRIGATION AND FERTILIZATION ON GROWTH OF A BEYOND 10 YEARS OLD SWITCHGRASS CROP	
Kyriakos D. GIANNOULIS, Thalia BATRA, Dimitrios BARTZIALIS, Ippolitos GINTSIODIS, Nicholaos G. DANALATOS	157
OLIVE OIL QUALITY CHARACTERISTICS UNDER ORGANIC AND INTEGRATED MANAGEMENT IN MESSINIA COUNTY GREECE	
Peter A. ROUSSOS, Asimina-Georgia KARIDA, Vassilios KAIBALIS	165
INVOLVEMENT OF EXOGENOUS COMPOUNDS APPLICATION ON OLIVE CUTTINGS ADVENTITIOUS ROOT FORMATION	
Petros A. ROUSSOS, Nikoleta-Kleio DENAXA	172
GERMINATION OF SEEDS OF CALLISTEPHUS CHINENSIS, CELOSIA ARGENTEA AND ZINNIA ELEGANS AFTER TREATMENT WITH DIFFERENT FERTILIZERS	
Marija MARKOVIĆ, Dragana SKOČAJIĆ, Danijela ĐUNISIJEVIĆ-BOJOVIĆ, Marija NEŠIĆ, Neda ORAŠANIN MILAKOVIĆ.....	178
GRAPHIC ANALYSIS OF SEED YIELD AND AGRONOMIC TRAITS IN CHICKPEA	
Naser SABAGHNIA, Mohsen JANMOHAMMADI.....	182
OPTIMIZING GERMINATION OF NEGLECTED AND UNDERUTILIZED VOANDZOU (VIGNA SUBTERRANEA) SEEDS: A COMPARATIVE STUDY OF PRE-TREATMENT METHODS AND MORPHOTYPES	
Abdel Kader NAINO JIKA, Hamissou AMADOU MOUNKAILA, Abdourahamane AMADOU BOUBACAR , Mahaman Rabiou HACHIMOU SABO, Grace NELKAM KILABÉ DJIMADOUM, Alhassane Gousmane AHMED.....	187
CORRELATION, HERITABILITY AND PATH ANALYSIS OF GRAIN YIELD COMPONENTS IN SOME MAIZE GENOTYPES (<i>Zea Mays</i> L.)	
Aleksandar KOVAČEVIĆ, Jovan PAVLOV, Milan STEVANOVIĆ, Nenad DELIĆ, Marko MLADENOVIĆ, Sanja PERIĆ	195
THE INFLUENCE OF COVER CROPS AND MICROBIOLOGICAL FERTILIZER ON YIELD AND YIELD COMPONENTS OF SWEET MAIZE (<i>Zea Mays</i> L. <i>sacharata</i> Sturt)	
Zeljko DOLIJANOVIC, Biljana SEVIC, Milena SIMIC, Vesna DRAGICEVIC, Snezana DJORDJEVIC, Nenad DJURIC.....	203
EFFECT OF CALCIUM CHLORIDE AND DURATION OF STORAGE ON THE QUALITY OF THE APPLE CULTIVAR ‘GLOSTER’	
Boris RILAK, Jelena TOMIĆ, Ivan GLIŠIĆ, Milan LUKIĆ, Žaklina KARAKLAJIĆ-STAJIĆ, Svetlana M. PAUNOVIĆ, Marijana PEŠAKOVIĆ	212
NEWLY CREATED ČAČAK’S SOUR CHERRY VARIETIES AS A RAW MATERIAL FOR SPIRIT PRODUCTION	
Branko POPOVIĆ, Sanja RADIČEVIĆ, Olga MITROVIĆ, Aleksandra KORICANAC, Ninoslav NIKIĆEVIĆ, Vele TEŠEVIĆ, Ivan UROŠEVIĆ	220

VARIABILITY OF SEED PROTEIN CONTENT AND SEDIMENTATION VOLUME IN WHEAT (*Triticum aestivum* L.)

Desimir KNEŽEVIĆ, Aleksandra Yu. NOVOSELSKAYA-DRAGOVICH, Alexander M. KUDRYAVTSEV, Mirela MATKOVIĆ STOJŠIN, Miodrag DIMITRIJEVIĆ, Sofija PETROVIĆ, Aleksandar PAUNOVIĆ, Danijela KONDIĆ, Veselinka ZEČEVIĆ..... 226

EVALUATION OF PEACH CULTIVARS OF EARLY AND MEDIUM-EARLY SEASON IN A HIGH DENSITY PLANTING

Dragan MILATOVIĆ, Đorđe BOŠKOV, Gordan ZEC, Aleksandar RADOVIĆ, Nemanja TEŠIĆ, Milana STOJANOSKI..... 234

NUTRITIONAL AND ECONOMIC BENEFITS OF TRITICALE CULTIVATION IN CURRENT GLOBAL CONDITIONS

Dragana LALEVIĆ, Milan BIBERDŽIĆ, Zoran S. ILIĆ, Lidija MILENKOVIĆ, Saša BARAĆ, Aleksandar VUKOVIĆ, Olivera ŠUŠA..... 240

PHENOTYPIC VARIABILITY AND SIMILARITY OF NUMBER OF SPIKELETS IN PRIMARY SPIKE IN WHEAT VARIETIES (*Triticum aestivum* L.)

Dušan UROŠEVIĆ, Desimir KNEŽEVIĆ, Mirela MATKOVIĆ STOJŠIN, Jelica ŽIVIĆ, Danica MIĆANOVIĆ, Adriana RADOSAVAC, Vesna KANDIĆ 247

THE EFFECTS OF EARLY AND LATE DEFOLIATION ON GRAPE YIELD AND GRAPE QUALITY OF PROKUPAC VARIETY

Dušica ĆIRKOVIĆ, Zoran BEŠLIĆ, Saša MATIJAŠEVIĆ, Bratislav ĆIRKOVIĆ, Dragana STANISAVLJEVIĆ, Zoran JOVANOVIĆ, Saša PETROVIĆ, Veroslava KOCIĆ 255

BIOLOGICAL PROPERTIES OF SWEET CHERRY CULTIVARS ON 'OBLAČINSKA' SOUR CHERRY ROOTSTOCK

Gordan ZEC, Dragan MILATOVIĆ, Ivana BAKIĆ, Đorđe BOŠKOV, Dejan ĐUROVIĆ, Boban ĐORĐEVIĆ, Milana STOJANOSKI..... 262

PREDICTING THE IMPACT OF CLIMATE CHANGE ON WATER AVAILABILITY FOR MAIZE CULTIVATION IN TOPLICA DISTRICT IN SERBIA

Dženita KOCA, Gordana MATOVIĆ, Erika GREGORIĆ, Vesna POČUČA, Mirjam VUJADINOVIĆ MANDIĆ..... 268

NUTRITIVE VALUE OF ITALIAN RYEGRASS-RED CLOVER MIXTURES DEPENDING ON THE SEEDING RATE IN THE MIXTURES

Jordan MARKOVIĆ, Tanja VASIĆ, Vladimir ZORNIĆ, Nedeljko RACIĆ, Filip BEKČIĆ, Marija STEPIĆ, Ivica KOSTIĆ..... 274

STATE OF EQUIPMENT WITH COMBINES IN AGRICULTURAL COOPERATIVE "AGROPROM"

Marija GAVRILOVIĆ, Miloš ZELIĆ, Biljana VELJKOVIĆ, Ranko KOPRIVICA..... 280

TRYPTOPHAN CONTENT INCREASE IN MAIZE INBRED LINES IMPROVED THROUGH MARKER ASSISTED BREEDING

Marija KOSTADINOVIĆ, Danijela RISTIĆ, Vesna PERIĆ, Dragana IGNJATOVIĆ-MIČIĆ, Jelena VANČETOVIĆ..... 287

INFLUENCE OF THE COVID-19 PANDEMIC ON THE IMPORT AND EXPORT OF CHRYSANTHEMUMS IN SERBIA

Marija MARKOVIĆ 294

CHARACTERISATION OF MUNG BEAN (*VIGNA RADIATA* L.) SEEDS USING FLUORESCENCE SPECTROSCOPY AND MULTIVARIATE ANALYSIS

Miloš PROKOPIJEVIĆ, Dragana BARTOLIĆ, Mira STANKOVIĆ, Ksenija RADOTIĆ 299

PROTEIN CONTENT IN SEED OF TRITICALE GROWN IN PURE CROP AND MIXTURE WITH PEAS

Milosav GRČAK, Dragan GRČAK, Desimir KNEŽEVIĆ, Radivoje JEVTIĆ, Vesna ŽUPANSKI, Dragan ŽIVANČEV, Vera RAJIČIĆ, Ivana JASNIĆ 304

EFFECTS OF IRRIGATION RATE AND PLANTING DENSITY ON MAIZE YIELD AND WATER USE EFFICIENCY IN THE TEMPERATE CLIMATE OF SERBIA

Miodrag TOLIMIR, Branka KRESOVIĆ, Željko KAITOVIĆ, Ljubomir ŽIVOTIĆ, Katarina GAJIĆ, Boško GAJIĆ 310

STRESS RESISTANCE INDICATORS AS THE TOOL FOR SELECTING DROUGHT-TOLERANT WHEAT GENOTYPES

Mirela MATKOVIĆ STOJŠIN, Veselinka ZEČEVIĆ, Dušan UROŠEVIĆ, Dragan BOŽOVIĆ, Jasmina BAČIĆ, Kamenko BRATKOVIĆ, Desimir KNEŽEVIĆ 318

ORGANIC FARMING: EXPLORING THE PROS AND CONS FOR SUSTAINABLE AGRICULTURE

Mirela TOMAŠ SIMIN, Marica PETROVIĆ, Bojana KOMAROMI 324

QUALITY OF OPERATION OF TECHNOLOGICAL-TECHNICAL SYSTEMS WITH DIFFERENT COMPRESSION CHAMBERS IN PREPARING ALFALFA HAY

Saša BARAĆ, Milan BIBERDŽIĆ, Aleksandar ĐIKIĆ, Dragana LALEVIĆ, Aleksandar VUKOVIĆ 333

EFFECT OF AZOTOBACTER SPP. ON INITIAL GROWTH OF GRASSES

Snežana ANĐELKOVIĆ, Dejan SOKOLOVIĆ, Zoran LUGIĆ, Goran JEVTIĆ, Jasmina RADOVIĆ, Jasmina MILENKOVIĆ, Snežana BABIĆ 340

GENETIC VARIABILITY AND HETEROSIS FOR MICRONUTRIENTS CONTENT IN MAIZE GENOTYPES

Snežana MLADENOVIĆ DRINIĆ, Danijela RISTIĆ, Milica NIKOLIĆ, Milomir FILIPOVIĆ, Željko KAITOVIĆ, Ana NIKOLIĆ, Violeta ANĐELKOVIĆ 346

PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOUR CHERRY (*PRUNUS CERASUS* L.) CULTIVARS

Svetlana M. PAUNOVIĆ, Žaklina KARAKLAJIĆ-STAJIĆ, Jelena TOMIĆ, Boris RILAK 353

RESPONSE OF DIFFERENT WHEAT GENOTYPES TO DROUGHT IN SEMI-ARID CLIMATE CONDITIONS

Veselinka ZEČEVIĆ, Vojislav STOJŠIN, Desimir KNEŽEVIĆ, Mirela MATKOVIĆ STOJŠIN, Slađana SAVIĆ, Dušan UROŠEVIĆ, Danica MIĆANOVIĆ 359

EFFECTS OF THE USE OF DIFFERENT FERTILIZATION RATES AND MICROBIOLOGICAL PRODUCTS ON WHEAT YIELDS

Vojin CVIJANOVIĆ, Marija BAJAGIĆ, Mladen PETROVIĆ, Nenad ĐURIĆ, Igor ĐURĐIĆ, Miloš STANKOVIĆ..... 365

QUALITY CHARACTERIZATION OF BLACKBERRY FRUITS (*Rubus subg. Rubus Watson*) IN DIFFERENT MATURITY STAGES

Žaklina KARAKLAJIĆ-STAJIĆ, Jelena TOMIĆ, Marijana PEŠAKOVIĆ, Svetlana M. PAUNOVIĆ, Boris RILAK..... 371

THE EFFECT OF DIFFERENT MICROBIAL FERTILIZERS ON THE WEEDINESS OF SOYBEAN

Željko DOLIJANOVIĆ, Milena SIMIĆ, Snežana OLJAČA, Dobrivoj POŠTIĆ, Snežana ĐORĐEVIĆ, Srđan ŠEREMEŠIĆ 378

EVALUATING THE ROLE OF PHENOLIC COMPOUNDS IN OLIVE BUD DIFFERENTIATION

Peter A. ROUSSOS, Dimitrios ZARIFOPOULOS, Asimina-Georgia KARYDA..... 383

EVALUATION OF YIELD COMPONENTS OF LETTUCE (*Lactuca sativa* L.) GROWN IN NUTRIENT FILM TECHNIQUE

Dragan ŽNIDARČIĆ..... 390

A NEW PROMISING LATE MATURING CLEMENTINE MANDARIN 'MARTIATIKI'

Peter A. ROUSSOS, Nikoleta-Kleio DENAXA, Athanasios TSAFOUROS, Efstathios NTANOS..... 397

EFFECT OF DIFFERENT FERTILIZERS ON SEED GERMINATION AND EARLY SEEDLING DEVELOPMENT OF TAGETES PATULA L.

Marija MARKOVIĆ, Dragana SKOČAJIĆ, Danijela ĐUNISIJEVIĆ-BOJOVIĆ, Marija NEŠIĆ, Neda ORAŠANIN MILAKOVIĆ..... 403

COMPARED AGRICULTURAL MACHINE SIZE MEASUREMENT WITH A CAD AND AN IMAGE ANALYSIS SOFTWARE

Abdullah BEYAZ..... 408

THE ROLE OF ADDITIVE MANUFACTURING COMPOSITE SHEETS FOR MECHANICAL PROPERTIES IN AGRICULTURAL MACHINERY PRODUCTION

Abdullah BEYAZ, Metehan KAZANCI..... 415

THE EFFICACY OF GLUTAMINE PRIMING ON GERMINATION AND SEEDLING DEVELOPMENT OF ROCKET IN SALT STRESS

Ayşe Gul NASIRCILAR Kamile ULUKAPI..... 423

PEAR BREEDING FOR THE FUTURE

Fatma Pınar ÖZTÜRK, Gökhan ÖZTÜRK, Emel KAÇAL, Dilek KARAMÜRSEL, Ayşegül SARISU, Melih AYDINLI, Ömer Faruk KARAMÜRSEL, İrfan NAZLI, Atakan GÜNEYLİ 430

CHARACTERIZATION OF HWM-GS AND EVALUATION OF QUALITY CHARACTERS IN ELITE SYNTHETIC WHEAT LINES

Ismet BAŞER, Feyza Tahan ÇAY, Damla Balaban GÖÇMEN, Alpay BALKAN, Oğuz BILGIN.....	436
THE EFFECT OF SOIL CONDITIONERS APPLIED TO SEED ON GRAIN YIELD AND YIELD TRAITS IN WHEAT	
Alpay BALKAN, Damla BALABAN GÖÇMEN, Oğuz BILGIN, İsmet BAŞER	444
GERMINATION AND EARLY SEEDLING DEVELOPMENT OF PURPLE CARROT TREATED WITH AMINO ACIDS	
Selin ŞİMŞEK, Ogulcan KARA, Ayse Gul NASIRCILAR, Kamile ULUKAPI.....	452
EFFECTS OF DIFFERENT ORGANIC MATERIALS ON PLANT WEIGHT AND DEHYDROGENASE ACTIVITY IN THE RHIZOSPHERE OF STRAWBERRY PLANTS	
Mohammed Gamal ABDELAZIZ ALI, Rıdvan KIZILKAYA.....	458
SEED PRIMING AGAINST TO DROUGHT STRESS	
Osman AYDENİZ, Sevinç BAŞAY	464
POSSIBILITY OF USING BANANA WASTE AS A SUBSTRATE FOR SUSTAINABLE AGRICULTURE UNDER SALT STRESS	
Ozlem SAHIN, Ayse Gul NASIRCILAR, Kamile ULUKAPI.....	470
INFLUENCE OF INTERCROPPING MAIZE WITH CLIMBING BEAN ON QUALITY AND YIELD OF FRESH FODDER	
Darko UHER, Zlatko SVEČNJAK, Martina KOVAČEVIĆ, Ivan HORVATIĆ	475
PhytoTester: PORTABLE INSTRUMENT FOR ASSESSMENT OF VITAL ACTIVITY OF THE VEGETABLE ORGANISMS	
Tamaz BICHIASHVILI, Shalva BICHIASHVILI.....	481
INFLUENCE OF MOWING HEIGHT AND PHENOLOGICAL STAGE OF MATURITY ON NUTRITIONAL VALUE OF ALFALFA HAY	
Aleksandar VUKOVIĆ, Dragana LALEVIĆ, Saša BARAĆ, Milan BIBERDŽIĆ, Rade STANISAVLJEVIĆ, Dragoslav ĐOKIĆ	487
IMPACT OF POLYETHYLENE MULCH AND LOW TUNNEL ON YIELD AND WATERMELON FRUIT CHARACTERISTICS	
Boris ADAMOVIĆ, Dušan PAROŠKI, Đorđe VOJNOVIĆ, Žarko ILIN.....	494
INDOOR SMART GARDEN: A NEW ERA IN PLANT PRODUCTION	
Branko MIHAILOVIĆ, Vesna POPOVIĆ, Katica RADOSAVLJEVIĆ	500
YIELDS OF NEW ONION CULTIVARS UNDER TWO SOWING METHODS	
Đorđe VOJNOVIĆ, Boris ADAMOVIĆ, Žarko ILIN	507
WEEDNESS AND FORAGE YIELD OF FIELD PEAS AND OATS MIXTURE CROP	
Vladeta STEVOVIĆ, Dalibor TOMIĆ, Miloš MARJANOVIĆ, Branka TRIFUNOVIĆ, Đorđe LAZAREVIĆ, Nenad PAVLOVIĆ, Milomirka MADIĆ	513
RESEARCH OF PHOSPHORUS (P) CONTENT IN AGRICULTURAL LAND	
Vladimir SABADOŠ, Danijela ŽUNIĆ	519

ANALYSIS OF PHYLOGENETIC VARIATION THE DOMINANT MICROORGANISMS GENUS OF *STENOTROPHOMONAS MALTOPHILIA* REVEALED FROM MUSHROOM

Tetiana IVANOVA..... 528

PLOIDY STUDY OF FESTUCA TAXA IN CARPATHIAN BASIN

Dániel BALOGH, Attila FŰRÉSZ, Károly PENKSZA, Antal SZŐKE, Csaba LANTOS 536

CONTROLLED-ENVIRONMENT VERTICAL FARMING IN ORNAMENTAL PLANT PRODUCTION AND APPLICATION OF A DECISION SUPPORT SYSTEM: THE EXAMPLE OF HYBRID AFRICAN VIOLET

Hamid Asım ÇÖKREN, Baran KAYNAK, Bahadır ŞİN, Numan ÇELEBİ 542

PLANT PROTECTION AND FOOD SAFETY 549

***SCLEROTINIA MINOR* AS A NEW PATHOGEN OF LETTUCE IN SERBIA**

Milica MIHAJLOVIĆ, Maja ŽIVANOVIĆ, Jovana HRUSTIĆ, Brankica PEŠIĆ 550

INSECTICIDES FLONICAMID AND PYRIPROXYFEN IN THE CONTROL OF GREENHOUSE WHITEFLY IN TOMATOES

Sanja LAZIĆ, Dragana ŠUNJKA, Slavica VUKOVIĆ, Jelena EĆIMOVIĆ, Dragana BOŠKOVIĆ, Aleksandra ŠUŠNJAR, Antonije ŽUNIĆ 556

INFLUENCE OF INSECTICIDES APPLICATION ON CHANNEL LENGTH IN STEM OF MAIZE PLANTS CAUSED BY FEEDING OF LARVAE OF EUROPEAN CORN BORER (*Ostrinia nubilalis* Hbn.)

Dragan GRČAK, Milosav GRČAK, Snežana GOŠIĆ-DONDO, Željko D. POPOVIĆ, Vanja TATIĆ, Iva UZELAC, Danijela KONDIĆ, Desimir KNEŽEVIĆ 563

EFFECTS OF PLANTS ESSENTIAL OIL AND PLANT POWDER ON THE MORTALITY OF SITOPHILUS GRANARIUS L.

Jana RAMMAL, Abdel KADER EL HAJJ 570

GLYPHOSATE RESIDUES IN GROUNDWATER IN SLOVAKIA

Erika REMEŠICOVÁ, Lucia MIŠUROVÁ, Adriana KUŠNIER PALUGOVÁ, Suzana TREŠNJIĆ IVANOVIĆ 576

SUSTAINABILITY IN OLIVE OIL PACKAGING

Turkan MUTLU KECELI 582

MICROBIOLOGICAL PURITY IN PRODUCTION, PROCESSING AND FOOD DISTRIBUTION

Bojan GOLIC, Biljana PEĆANAC, Dragan KNEŽEVIĆ 586

VARIABILITY OF TWO-YEAR-OLD SEEDLINGS OF *GINKGO BILOBA* L. GROWN FROM SEED COLLECTED IN THE CITY AREA OF BELGRADE (SERBIA)

Filip JOVANOVIĆ, Sonja BRAUNOVIĆ, Natalija MOMIROVIĆ, Ljubinko RAKONJAC, Ivana ŽIVANOVIĆ 594

OVERVIEW OF THE FACTORS THAT INFLUENCE FEED SAFETY AND QUALITY

Aleksandra ANGELESKA, Radmila CRCEVA NIKOLOVSKA, Elizabeta DIMITRIESKA STOJKOVIC, Sandra MOJSOVA, Igor ESMEROV, Ljupco ANGELOVSKI	600
ANTIFUNGAL ACTIVITY OF RHIZOBIA AGAINST RED CLOVER PATHOGENS FROM GENUS FUSARIUM	
Filip BEKČIĆ, Nataša DUDUK, Zoran LUGIĆ, Jasmina RADOVIĆ, Snežana BABIĆ, Marija STEPIĆ, Snežana ANDJELKOVIĆ	607
ENTOMOFAUNA ON WHEAT AND BARLEY IN BIJELJINA AREA (BOSNIA AND HERZEGOVINA)	
Dejana STANIĆ, Slađan TRIŠIĆ	613
A SAMPLE PREPARATION METHODOLOGY USING DIFFERENT d-SPE SORBENT FOR AMITRAZ ANALYSIS IN HONEY	
Aleksandra TASIĆ, Ivan PAVLOVIĆ, Tanja BIJELIĆ	622
CONTROL OF <i>CYDIA POMONELLA</i> L. IN APPLE ORCHARDS USING A MIXTURE OF INSECTICIDES	
Slavica VUKOVIĆ, Dragana ŠUNJKA, Sanja LAZIĆ, Antonije ŽUNIĆ, Aleksandra ŠUŠNJAR, Miloš PETROVIĆ, Dragana BOŠKOVIĆ	630
SURVEY OF THE POSSIBLE PRESENCE OF <i>Xylella fastidiosa</i>, THE CAUSAL AGENT OF PIERCE'S DISEASE OF GRAPEVINE AND OTHER PLANT DISEASES IN REPUBLIC OF SRPSKA	
Vojislav TRKULJA, Gordana BABIĆ, Bojana VUKOVIĆ, Bojana ĆURKOVIĆ, Jovana PRIJIĆ, Bogdan NEDIĆ	635
DETERMINATION OF CONTENT AND COMPOSITION OF ESSENTIAL OIL OF <i>ORIGANUM VULGARE</i> L. FROM THE REGION OF HERZEGOVINA	
Zoranka MALEŠEVIĆ, Selena ĆEVRIZ, Đorđe ILIĆ, Mirjana JOVOVIĆ, Dragana VUKOVIĆ, Aleksandra GOVEDARICA-LUČIĆ	642
ANTIFUNGAL ACTIVITY OF THREE CHEMOTYPES OF <i>SATUREJA MONTANA</i> ESSENTIAL OIL AGAINST <i>ALTERNARIA ALTERNATA</i>	
Sara MIKIĆ, Tatjana STEVIĆ, Snežana MRĐAN, Željana PRIJIĆ, Stefan GORDANIĆ, Vladimir FILIPOVIĆ, Ana DRAGUMILO, Tatjana MARKOVIĆ	648
THE IMPACT OF <i>BOTRYTIS CINEREA</i> ON INDIVIDUAL PHENOLIC COMPOUNDS IN CABERNET SAUVIGNON WINE	
Nikolina ŽIVKOVIĆ, Danka MITROVIĆ, Ivana PLAVŠIĆ JANJATOVIĆ, Aleksandar PETROVIĆ	653
THE SITE AND TEMPERATURE EFFECT ON <i>IN VITRO</i> POLLEN PERFORMANCE OF SOME CHERRY CULTIVARS	
Slavica ČOLIĆ, Vera RAKONJAC, Radosav CEROVIĆ, Milena ĐORĐEVIĆ, Ivana GLIŠIĆ, Sanja RADIČEVIĆ	657
MELISSOPALYNOLOGICAL ANALYSIS OF HONEY SAMPLES FROM BOSNIA AND HERZEGOVINA	
Danijela PETROVIĆ, Helena BREKALO, Antonela MUSA, Sandra MEDIĆ	666

DIVERSITY OF SOIL-DWELLING INSECTS THAT ATTACK MAIZE AND SUNFLOWER CROPS FROM SOUTH AND SOUTHEASTERN ROMANIA

Maria IAMANDEI, Andrei CHIRILOAIE-PALADE, Raluca GEORGESCU, Mădălina RĂDULEA, Ionuț-Cristian POPA 672

SUSTAINABILITY IN OLIVE LEAVES FOR FUNCTIONAL FOOD INGREDIENTS PRODUCTION

Turkan MUTLU KECELI 678

FOOD SAFETY FOR OLIVE OIL

Turkan MUTLU KECELI 682

COMBINING OF TWO PREDATOR, *ORIOUS LAEVIGATUS* (FIEBER) (HEMIPTERA: ANTHOCORIDAE) AND *SERANGIUM PARCESETOSUM* SICARD (COLEOPTERA: COCCINELLIDAE) IN PROTECTED EGGPLANT GROWING

Mehmet KEÇEÇİ, Ali ÖZTOP 686

INVESTIGATION OF THE COMBINED HARMFUL EFFECTS OF CHLORPYRIFOS AND CYPRODINIL ON PHEASANT EMBRYOS

Rita SZABÓ, László MAJOR, József LEHEL, Bence BALÁZS, Nadhirah Binti SAIDON, Péter BUDAI 697

TROPHIC INTERACTIONS AND DYNAMICS OF *APHIS SPIRAECOLA* PATCH ON CITRUS TREES IN PROXIMATE PLOTS, MOSTAGANEM, ALGERIA

Zine Eddine LABDAOUI, Abd El Basset BOUKHOUNA, Mohamed MAHMOUDI, Yamina GUENAOUI 704

FIRST FINDING IN EUROPE OF *COLLETOTRICHUM SCOVILLEI*, A NEW AGENT OF PEPPER ANTHRACNOSE AND ASSESSMENT OF POTENTIAL BACTERIAL BIOCONTROL AGENTS

Bekri XHEMALI, Marina CORTIELLO, Gazmend GJINOVCI, Betim BRESILLA, Francesco MODICA, Emilio STEFANI, Davide GIOVANARDI 712

FUMONISIN LEVELS IN CORN AND CORN PRODUCTS IN SERBIA IN 2022

Anja VUKSAN, Danka MITROVIĆ, Marko JAUKOVIĆ 718

BASIC CHARACTERISTICS, APPLICATION AND SAFETY OF STEVIA REBAUDIANA BERTONI – A LOW-CALORIE NATURAL SWEETENER IN FOOD

Višnja SIKIMIĆ, Slavica ČABRILO, Milica ALEKSIĆ, Jovanka POPOV – RALJIĆ ... 722

FIELD DIGITIZATION AND DECISION SUPPORT SYSTEM (DSS) IN PEACH CULTIVATION TO MANAGE THE MEDITERRANEAN FRUITFLY, *CERATITIS CAPITATA* IN TUNISIA

Mohamed BRAHAM, Hassib BEN KHEDHER, Ahmed MOUSSA 730

ORGANIC AGRICULTURE..... 739

ANTIOXIDANT PROPERTIES OF BLACK CURRANT BERRIES (*Ribes nigrum* `Titania`)

Ladislav VASILIŠIN, Goran VUČIĆ, Srdjan LJUBOJEVIĆ, Ana VELEMIR 740

ATTITUDES OF PRODUCERS' TOWARDS DISTRIBUTION CHANNELS OF ORGANIC PRODUCTS IN THE REPUBLIC OF CROATIA	
Irena PUGELNIK	746
CO-CULTIVATION AS A PLANTING STRATEGY FOR QUALITATIVE AND QUANTITATIVE PLANT GROWTH AND ENVIRONMENTAL PROTECTION	
Kristina Ilektra MAKNEA, Violeta Alexandra ION, Adrian ASANICA.....	752
ENVIRONMENT PROTECTION AND NATURAL RESOURCES MANAGEMENT	760
RELATIONSHIPS BETWEEN WILD FLORA, CROPS, APHIDS (HEMIPTERA, APHIDIDAE) AND THEIR NATURAL ENEMIES IN CITRUS ORCHARDS	
Samir ALI-AROUS, Malika MEZIANE, Khaled DJELOUAH	761
SOIL WETNESS AND VEGETATION TYPES OF SEMBERIJA REGION (BOSNIA AND HERZEGOVINA) ACCORDING TO COPERNICUS DATABASE	
Branislav DRAŠKOVIĆ Goran SRDIJA, Zoran SRDIJA	769
POLLINATION AND SEASONAL DYNAMICS OF ANEMOPHILIC FLORA IN THE AREA OF THE CITY OF MOSTAR IN BOSNIA AND HERZEGOVINA	
Danijela PETROVIĆ, Toni GALIĆ, Mate BOBAN, Helena BREKALO	774
STATE OF VASCULAR FLORA IN THE ENVIRONMENT OF BORAČKO LAKE IN BOSNIA AND HERZEGOVINA AND SUSTAINABLE DEVELOPMENT	
Emina ADEMOVIĆ, Ana KNEŽEVIĆ.....	780
ADVANCEMENTS IN ROBOTICS, SMART FARMING, AND COMPUTER VISION: REVOLUTIONIZING AGRICULTURE	
Vesna RADOJČIĆ, Aleksandar Sandro CVETKOVIĆ	787
THE CALCULATION OF GHG EMISSIONS OF CULTIVATED CROPS AND USAGE OF THESE CROPS IN FEED MIXTURES IN ANIMAL NUTRITION	
Pavel ČERMÁK, Eva WEISBAUEROVÁ, Martin DĚDINA, Petr JEVIČ, Tomáš LOŠÁK	795
IMPROVING LANDSCAPE RESILIENCE IN THE MEDITERRANEAN AGAINST CLIMATE CHANGE THREATS: THE "RESALLIANCE" PROJECT	
Gavriil XANTHOPOULOS, Eduard MAURI, Eduard PLANA, Evangelia AVRAMIDOU	800
"ON EITHER SIDE OF THE ELECTRIC FENCE" (A BOTANICAL STUDY OF THE AUTUMNAL ASPECT OF THE DRAINED LAKE BED OF A DOMESTIC WATER BUFFALO PASTURE IN THE ZÁMOLYI BASIN)	
Dániel BALOGH, Károly PENKSZA, Levente VISZLÓ, Gabriella KEMÉNY, Attila FÜRÉSZ	807
EFFECT OF DIFFERENT SHRUB SPECIES ON SOIL: SEED BANKS CHEMICAL AND BIOLOGICAL PROPERTIES	
Reza ERFANZADEH, Shadi HAZHIR, Alireza MOHEBALI	813
THE COLLECTION OF <i>HOSTA</i> Tratt FROM "AL. CIUBOTARU" NATIONAL BOTANICAL GARDEN (INSTITUTE)	

Irina SFECLA.....	820
REMOVAL OF THE WATER FROM FENAMIPHOS PESTICIDE IN THE SOIL USING MORINGA OLEIFERA	
Ashraf KABAR, Iman IBRAHIM, Zaainaldeen NASSAR, Nasser Abu GALWA, Fawzi KODIH	827
PURIFICATION OF WATER FROM CHLORPYRIFOS IN THE SOIL BY USING MORINGA OLEIFERA	
Ashraf KABAR , Iman IBRAHIM, Nasser Abu GHALWA, Fawzi KODIH.....	836
SEASONAL VARIATIONS OF FLOWERING OF <i>Amorpha fruticosa</i> L. AS AN INDICATOR OF GLOBAL WARMING IN BLUE-GREEN INFRASTRUCTURE	
Mirjana OCOKOLJIĆ, Đurđa PETROV, Dragan VUJIČIĆ, Nevenka GALEČIĆ.....	846
EFFECTS OF CLIMATE PARAMETERS ON BLACKTHORN IN AGROFORESTRY ECOTONES AS GREEN ROAD INFRASTRUCTURE ELEMENTS	
Mirjana OCOKOLJIĆ, Đurđa PETROV, Dragan VUJIČIĆ, Nevenka GALEČIĆ	853
PHYSICAL, CHEMICAL AND MICROBIOLOGICAL ANALYSIS OF DRINKING WATER ON THE TERRITORY OF PROKUPLJE (SERBIA)	
Svetlana BOGDANOVIĆ, Moma DENIĆ, Ivana ZLATKOVIĆ, Dobrila RANĐELOVIĆ, Dragana STANISAVLJEVIĆ.....	859
CHARACTERIZATION OF DIFFUSE PHOTOSYNTHETICALLY ACTIVE RADIATION IN BURGOS (SPAIN)	
Ana GARCIA-RODRIGUEZ, Sol. GARCIA-RODRIGUEZ, Elena GARRACHON-GOMEZ, Diego. GRANADOS-LOPEZ, Cristian TERRADOS-LOPEZ.....	864
CHARACTERIZATION OF ERYTHEMAL ULTRAVIOLET RADIATION IN BURGOS, SPAIN	
Sol GARCIA-RODRIGUEZ, Ana GARCIA-RODRIGUEZ, Elena GARRACHON-GOMEZ, Ignacio GARCIA, David GONZALEZ-PEÑA.....	869
INFLUENCE OF COVER CROPS ON SOIL BIOLOGICAL QUALITY	
Mário DUARTE, Elsa VALÉRIO, Rosa Santos COELHO, Maria GODINHO.....	876
STATUS OF RADIONUCLIDES IN THE SOILS FROM VOJVODINA PROVINCE, NORTHERN SERBIA	
Željko MIHALJEV, Milica ŽIVKOV BALOŠ, Sandra JAKŠIĆ, Marija MIHALJEV, Nenad POPOV.....	883
SHEEP FARMERS' PERCEPTION OF CLIMATE CHANGE: CASE OF KONYA PROVINCE, TÜRKİYE	
Cennet OĞUZ, Aykut ÖRS, Aysun YENER ÖĞÜR, Yusuf ÇELİK	888
RESEARCH ON RECREATIONAL VALUE OF FOREST PARKS BASED ON CHOICE EXPERIMENT METHOD: A CASE STUDY OF WUYI MOUNTAIN IN CHINA	
Yimeng ZHANG, Yuanyuan YI.....	894
PREDICTIVE CLASSIFICATION OF AQUACULTURE FISH MORTALITY USING DATA MINING CLASSIFIERS	

Dimitris C. GKIKAS, Marios C. GKIKAS, John A. THEODOROU.....	900
A MONTHLY STUDY OF INTERCEPTED PHOTOSYNTHETICALLY ACTIVE RADIATION (IPAR) FOR VINEYARDS IN CASTILLA Y LEÓN	
Elena GARRACHÓN-GÓMEZ , Ana GARCÍA-RODRÍGUEZ, Sol GARCÍA-RODRÍGUEZ, Manuel GARCÍA-FUENTE.....	908
ANIMAL HUSBANDRY	914
CHARACTERIZATION AND IDENTIFICATION OF POTENTIAL PROBIOTIC LACTIC ACID BACTERIA ISOLATED FROM EGYPTIAN TRADITIONAL FERMENTED DAIRY PRODUCTS	
Nesreen M. NASR, Walaa M. BAHNAS, Khaled A. ABBAS.....	915
HIPPOTHERAPY IN THE CONTEXT OF MODERN METHODS OF REHABILITATION	
Igor V. GONCHARENKO.....	926
EFFECT OF DIFFERENT STOCKING DENSITIES IN THE OUTDOOR AREA ON BROILER PERFORMANCE CHARACTERISTICS	
Omer EREN, Ali AYGUN, Dogan NARINC	931
COMPARISON OF THREE DIFFERENT LAYER GENOTYPES RAISED IN A FREE-RANGE SYSTEM FOR EGG QUALITY	
Ali AYGUN, Dogan NARINC, Hasan ARISOY	936
MICROBIOLOGICAL STATUS AND MOLD CONTENT IN MILK AND FEED MIXTURES WITH THE ADDITION OF ADDITIVES	
Aleksandra JEVIĆ, Saša PEŠEV, Nikola STOLIĆ, Bratislav PEŠIĆ, Nebojša ZLATKOVIĆ	941
REFERENCE INTERVALS OF HEAVY METALS IN THE MUSCLE TISSUE OF CATTLE CONSIDERING PARATYPIC FACTORS	
Kirill NAROZHNYKH	948
STUDY ABOUT THE MODE OF IMPLEMENTATION OF THE BREEDING PROGRAM ON ABERDEEN ANGUS BREED IN ROMANIA	
Dragoş Florin MANEA, Vasile MACIUC	955
ASSESSMENT OF THE ECONOMIC VIABILITY OF SUCKLER COW BREEDING MODEL	
Luis SANTA MARIA	962
SENSORS DATA IN AUTOMATIC MILKING SYSTEM AND MASTITIS	
Katarina PANDŽIĆ, Zrinko MIKIĆ, Zdenko IVKIĆ, Drago BEŠLO, Pero MIJIĆ, Tina BOBIĆ.....	968
TOP-DOWN AND BOTTOM-UP REGULATIONS AT THE ALGERIAN COASTS (1°W – 8°E): MODELING OF COPEPODA - MEDUSOZOA RELATIONSHIPS	
Lilia MELLAK, Aldjia KHERCHOUCHE, Selman CHABANI, Aziz HAFFERSSAS ..	976
THE HUMAN ANIMAL RELATIONSHIP IN DAIRY FARMING	
Nassima BOUHROUM, Belmehel BENSAPHLI.....	984

PERIPHERAL INDICATORS OF ACIDOSIS IN DAIRY COWS

Nassima BOUHROUM, Belmehel BENSAHLI 988

EVOLUTION OF BIOCHEMICAL PARAMETERS IN POST PARTUM COWS AFFECTED WITH BRUCELLA

Nassima BOUHROUM, Belmehel BENSAHLI, Abdellatif NIAR 993

INFLUENCE OF ULTRASONIC TREATMENT ON THE FERMENTATION OF GOAT'S MILK SUPPLEMENTED WITH MILK PROTEIN ISOLATES

Tanja VUCIC, Snezana JOVANOVIĆ, Marija MILETIĆ GLIŠIĆ 999

TWO GENETIC VARIANTS IN *EBF1* GENE EFFECT ON LIVE WEIGHT IN SHEEP

Varvara SHEVTSOVA, Lyubov GETMANTSEVA, Yuri KOLOSOV, Alexander USATOV 1006

***IN OVO* α -TOCOPHEROL MODIFIES SERUM LIPID PROFILE BY GENDER OF BROILER CHICKS AT 72TH-HOUR OF POST-HATCHING STAGE**

Elif BABACANOĞLU ÇAKIR, Mehmet Reşit KARAGEÇİLİ 1010

CURRENT SITUATION OF CATTLE HUSBANDRY AND BREEDING POSSIBILITIES IN BİNGÖL PROVINCE OF TÜRKİYE

Turgut AYGÜN 1015

OCCUPATIONAL AND ZONOTIC DISEASES IN LIVESTOCK SECTOR

Turgut AYGÜN 1021

USE OF SERUM LEVELS OF FSH AND LH AS INDIRECT SELECTION CRITERION IN GENETIC IMPROVEMENT OF REPRODUCTION IN SHEEP

Turgut AYGÜN 1027

THE INFLUENCE OF THE NUTRITIONAL STATUS OF DAIRY COWS ON THEIR WELL-BEING

Zrinko MIKIĆ, Katarina PANDŽIĆ, Zdenko IVKIĆ, Drago BEŠLO, Pero MIJIĆ, Tina BOBIĆ 1033

EVALUATION OF BIRTH WEIGHT BY BANDED MEASURE IN SELECTED BREEDING HERD OF SLOVAK SPOTTED BREED

Jozef BUJKO, Juraj CANDRÁK, Peter STRAPÁK, Cyril HRNČÁR, Mariusz BOGUCKI, Dariusz KOKOSZYŃSKI 1039

TICK FAUNA OF SHEEP IN EAST SERBIA

Ivan PAVLOVIĆ, Jovan BOJKOVSKI, Violeta CARAO PETROVIĆ, Milan P.PETROVIĆ, Aleksandra TASIĆ, Marija PAVLOVIĆ, Dragica VOJINOVIĆ 1045

PHENOTYPE EVALUATION OF GATAČKO CATTLE FROM THE TERRITORY OF GATAČKO MUNICIPALITY IN BOSNIA AND HERZEGOVINA

Jelena NIKITOVIC, Dusan ANDRIJASEVIC, Tatjana KRAJISNIK, Zoran MALETIC, Milan PUZIGACA 1051

THE EFFECT OF POTASSIUM HUMATE ON THE PRODUCTIVITY, HAEMATOLOGICAL AND BIOCHEMICAL BLOOD PARAMETERS OF DAIRY COWS

Aiga NOLBERGA-TRŪPA, Aija MĀLNIECE, Aivars POĻAKOVŠ 1057

THE IMPACT OF BREEDING HONEYBEES IN DIFFERENT REGIONS OF SERBIA AND BOSNIA AND HERZEGOVINA ON THEIR MORPHOMETRIC PARAMETERS

Aleksandar IGNJATOVIĆ, Nebojša NEDIĆ, Goran MIRJANIĆ, Predrag PERIŠIĆ, Goran JEVTIĆ..... 1065

POPULATION STRUCTURE OF THE ENDEMIC MAKAL DACE (SQUALIUS MICROLEPIS HECKEL, 1843) FROM THE MATICA RIVER

Predrag IVANKOVIĆ, Leona PULJIĆ, Zrinka KNEZOVIĆ 1071

STATUS OF THE MIGRATORY BEEKEEPING IN LATVIA

Aleksejs ZACEPINS, Valters BRUSBARDIS, Olvija KOMASILOVA, Armands KVIESIS, Vitalijs KOMASILOVS 1076

ASSESSMENT OF THE MICROBIOLOGICAL STATUS OF DRINKING WATER ON ANIMAL FARMS

Bojan GOLIC, Dragan KNEŽEVIĆ, Biljana PEĆANAC 1086

NUTRITIONAL VALUES OF DOMINANT FESTUCA SPECIES IN SANDY GRASSLANDS ALONG THE DANUBE BASED ON A SYSTEMATIC SAMPLING

Attila FÜRÉSZ, László SIPOS, Ferenc PAJOR, Péter PENKSZA, Károly PENKSZA 1094

THE INFLUENCE OF AGE ON REPRODUCTIVE CHARACTERISTIC IN SIMMENTAL COWS

Jelena NIKITOVIC, Tatjana KRAJISNIK, Stevan RAJIC 1102

THE INFLUENCE OF ALTITUDE ON THE QUALITY OF HONEY IN CENTRAL SERBIA

Goran JEVTIĆ, Snežana BABIĆ, Snežana ANĐELKOVIĆ, Đorđe LAZAREVIĆ, Mirjana PETROVIĆ, Kazimir MATOVIĆ, Nebojša NEDIĆ 1109

EFFECTS OF BREEDER AGE ON EGG QUALITY TRAITS IN JAPANESE QUAILS

Medine KAYA, Ali AYGÜN, Doğan NARİNC 1115

HOLSTEIN BREED LIVESTOCK IN GEORGIA

Tamar QACHASHVILI, Amrosi CHKUASELI, Giorgi KHATIASHVILI, Jemal KHATIASHVILI..... 1120

AN OVERVIEW OF THE CURRENT STATE OF GRASSLANDS IN THE PODRINJE REGION AS A SOURCE OF HEALTHY ANIMAL FEED

Mirjana PETROVIĆ, Vladimir ZORNIĆ, Jasmina RADOVIĆ, Nedeljko RACIĆ, Dejan SOKOLOVIĆ, Svetlana JERINIĆ, Zoran LUGIĆ..... 1127

IMPROVING POSSIBILITIES OF INDIGENOUS HAIR GOAT BREEDING IN BİNGÖL PROVINCE IN TÜRKIYE

Emre ALARSLAN, Turgut AYGÜN..... 1132

BREEDING TECHNOLOGIES FOR HIGH LAMB CARCASS QUALITY

Angela CIVIDINI..... 1139

RURAL DEVELOPMENT AND AGRO-ECONOMY..... 1145

DIVERSIFICATION OF AGRICULTURAL VALUE CHAINS AND RURAL DEVELOPMENT IN MALI: CASE OF KITA CERCLE

Innocent MUMARARUNGU, Bisetsa ERICKSON, Gisaro Ca- Madeberi Ya BITITI, Philippe BURNY 1146

THE ECONOMIC IMPORTANCE OF AGRICULTURE AND TOURISM FOR THE ECONOMIC DEVELOPMENT OF BOSNIA AND HERZEGOVINA

Adriana RADOSAVAC, Ružica ĐERVIDA, Gordana PETROVIĆ, Tatjana IVANOVIĆ, Desimir KNEŽEVIĆ 1154

AGRICROWDFUNDING AS AN INNOVATIVE AGRI-FINANCING MODEL

Zorica GOLIĆ, Nedeljka ELEZ 1163

REGIONAL SOCIO-ECONOMIC IMBALANCES IN BULGARIA

Angel SAROV 1172

EFFECT OF THE TRANSITION TOWARDS CIRCULAR ECONOMY

Monika SABEVA 1180

YOUNG CONSUMERS AND ETHICAL MEAT CONSUMPTION

Martina SALOVA, Zbynek ULCAK 1186

VITALITY OF EDUCATION ORGANIZATIONS IN QALIUBIYA RURAL AREAS (CASE STUDY IN SHEBIN DISTRICT IN EGYPT)

Mazen MOHAMED BARAKAT 1193

APPLYING CATEGORICAL REGRESSION FOR EXPLORING VETERINARY STUDENTS' ATTITUDES TOWARDS CAREER PERSPECTIVES

Athanasios BATZIOS, Vagis SAMATHRAKIS, Alexandros THEODORIDIS, Georgia KOUTOUZIDOU, Alexandros KAKOURIS 1200

A SOCIAL NETWORK ANALYSIS ON THE COLLABORATIVE CONSERVATION OF RANGELANDS IN LOCAL COMMUNITIES OF IRAN

Fatemeh BORNA, Iman ISLAMI, Hossein AZADI 1207

MODELING THE TIME SERIES OF RASPBERRY YIELDS IN THE REPUBLIC OF SERBIA USING THE ARIMA MODEL

Angelina PETKOVIĆ, Svjetlana JANKOVIĆ-ŠOJA 1213

IMPORTANT PARTNERS OF SERBIA IN THE FOREIGN TRADE EXCHANGE OF FOOD

Biljana VELJKOVIĆ, Ranko KOPRIVICA, Marija GAVRILOVIĆ, Milun D. PETROVIĆ, Simeon RAKONJAC 1218

FORECAST OF AND TRENDS IN THE SERBIAN RASPBERRY PRODUCTION

Mirjana LUKAČ BULATOVIĆ, Katarina ĐURIĆ 1225

THE INFLUENCE OF CORN AND FATTENING PIGS PRICE FROM CURRENT YEAR ON THE NUMBER OF FATTENING PIGS IN FOLLOWING YEAR

Nebojša NOVKOVIĆ, Ljiljana DRINIĆ, Nataša VUKELIĆ, Veljko ŠARAC 1232

DISTRIBUTION AND EFFICIENCY OF ECONOMIC SUBSIDIES FOR SOIL CONSERVATION ALONG TWO DECADES IN SPAIN

Mistral VAN OUDENHOVE, Pedro PÉREZ CUTILLAS, Carolina BOIX FAYOS 1238

GREEN BONDS AS A FINANCIAL TOOL TO SUPPORT AGRICULTURAL SECTOR – OPPORTUNITIES AND CHALLENGES

Zorica GOLIC, Saša LALIĆ 1245

EXPANSION AND DECLINE OF NATURAL RUBBER EXPORTATIONS IN THE BRAZILIAN AMAZON REGION

José de Jesus Sousa LEMOS 1255

THE INFLUENCE OF INTERNATIONAL MARKETS ON BARLEY PRICES IN THE REPUBLIC OF NORTH MACEDONIA

Lazo DIMITROV, Marija GJOSHEVA KOVACHEVIKJ, Despina POPOVSKA STOJANOV, Sreten ANDONOV, Sasho KJOSEV, Bodan ANDONOV 1265

THE LAND CONSOLIDATION INFLUENCE ON DEMOGRAPHY: CASE STUDY ON VOJVODINA IN SERBIA

Goran MARINKOVIĆ, Žarko NESTOROVIĆ, Zoran ILIĆ, Marko BOŽIĆ 1272

FORESTRY AND AGRO-FORESTRY 1277

STRUCTURAL AND FUNCTIONAL RESPONSES OF *ALNUS GLUTINOSA* [L.] GAERTN. TREES ON DIFFERENT SITE TYPES IN CENTRAL BOSNIA

Mirsada STARČEVIĆ, Azra ČABARAVDIĆ 1278

SEASONAL CHANGES OF FUNCTIONAL RESPONSES ON *ALNUS GLUTINOSA* (L.) GAERTN. SITES

Mirsada STARČEVIĆ, Azra ČABARAVDIĆ 1285

POSSIBILITIES AND DIFFICULTIES OF MEASURING CARBON SEQUESTRATION IN AGROFORESTRY SYSTEMS IN HUNGARY

Orsolya SZABÓ, Tamás MOLNÁR, Éva Ilona KIRÁLY, Attila BOROVIK, Zsolt KESERŰ..... 1292

MACHINE LEARNING METHODS FOR LAND COVER AND TREE SPECIES CLASSIFICATION USING GOOGLE EARTH ENGINE

Tamás MOLNÁR, Géza KIRÁLY 1299

TAXONOMY AND PHYTOGEOGRAPHY ANALYSIS OF MEDICINAL PLANTS AT THE AREA OF NATURE MONUMENT "ŠUMA KOŠUTNJAK"

Dušan JOKANOVIĆ, Vesna NIKOLIĆ JOKANOVIĆ, Kristina ŽIVANOVIĆ, Ivan DESIMIROVIĆ, Jovana DEVETAKOVIĆ, Marina NONIĆ 1305

PREVIEW OF MEDICINAL PLANTS WITHIN LOWLAND PEDUNCULATE OAK FORESTS AND THEIR USEFUL PROPERTIES

Dušan JOKANOVIĆ, Vesna NIKOLIĆ JOKANOVIĆ, Kristina ŽIVANOVIĆ, Ivan DESIMIROVIĆ, Radoslav LOZJANIN, Tihomir ŠOŠKIĆ 1311

SEASONAL DYNAMICS OF INSECT COMMUNITIES AND THREE MAJOR PESTS IN FRUŠKA GORA NATIONAL PARK (SERBIA)

Dušanka VUJANOVIĆ, Jelena JOVIĆ, Maja AROK, Marija MILIČIĆ, Andrijana ANDRIĆ..... 1317

FLORISTIC AND ECOLOGICAL ANALYSIS OF BLACK PINE FORESTS (*Pinus nigra* Arn.) ON WESTERN BALKAN SERPENTINITES

Marijana NOVAKOVIĆ-VUKOVIĆ.....	1324
SYSTEM MONITORING OF THE CROWN CONDITION ON ICP FORESTS SAMPLE PLOTS LEVEL I IN SERBIA WITH A SPECIAL VIEW OF BIOTIC DAMAGE ON PLOTS WITH OAK AS THE EDIFIER	
Miroslava MARKOVIĆ, Renata GAGIĆ-SERDAR, Goran ČEŠLJAR, Snežana STAJIĆ, Natalija MOMIROVIĆ.....	1333
EDAPHIC CHARACTERISTICS OF THE PARK IN THE ŠARENGRAD AREA IN NOVI SAD IN SERBIA	
Saša PEKEČ, Miroslav MARKOVIĆ , Predrag PAP, Saša KOSTIĆ, Marina MILOVIĆ, Andrej PILIPOVIĆ, Milutin ĐILAS	1339
DEMOGRAPHIC OF EMPLOYEES IN PUBLIC FOREST ENTERPRISES AS FACTOR FOR IMPROVEMENT OF FOREST PRODUCT AND SERVICES	
Zoran PODUŠKA, Snežana STAJIĆ, Branka PAVLOVIĆ, Vlado ČOKEŠA.....	1344
CHARACTERISTICS OF LOWER NON-AGRICULTURAL SOILS IN THE NORTH BANAT REGION, MUNICIPALITY OF KIKINDA AND POSSIBILITIES FOR THEIR AFFORESTATION	
Miodrag RADOVANOVIĆ, Zoran GALIĆ, Velisav KARAKLIĆ, Milutin ĐILAS	1351
BACTERIAL TREATMENT IMPACT ON ONE-YEAR-OLD SESSILE OAK (<i>QUERCUS PETRAEA</i> (MATT.) LIEBL) SEEDLINGS OF THREE SERBIAN PROVENANCES	
Sanja JOVANOVIĆ, Vladan POPOVIĆ, Aleksandar LUČIĆ, Ljubinko RAKONJAC	1357
AWARENESS AND ADOPTION OF SCIENTIFIC AGRICULTURAL PRACTICES IN AGROFORESTRY HOME GARDENS WITH SPECIAL REFERENCE TO WELIGAMA, SRI LANKA	
Malghaha Gamage Dilshani ABEYSINGHE, Ganganee Chandima SAMARAWEERA, Mangala DE ZOYSA	1362
AUTHOR INDEX.....	1372

PLANT PROTECTION AND FOOD SAFETY

**VARIABILITY OF TWO-YEAR-OLD SEEDLINGS OF *GINKGO BILOBA* L.
GROWN FROM SEED COLLECTED IN THE CITY AREA OF BELGRADE
(SERBIA)**

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Abstract

Ginkgo biloba L. (*Ginkgoaceae*), known as ginkgo, is a species of gymnosperm tree native to China, but also a popular ornamental tree in Europe and North America. It is a very suitable species for cultivation in shelterbelts, multiple-purpose plantations, and urban conditions. On the territory of the Republic of Serbia, ginkgo occurs in green areas mainly as individual trees, or in smaller groups, rarely in tree rows. In the wider zone of the city of Belgrade, 94 trees are found. The analysis of several morphological traits and phenotypic characteristics of two-year-old ginkgo seedlings in the test with seven half-sib lines sampled from green spaces of Belgrade was conducted in order to provide the basis for planting stock selection and the establishment of plantations adapted to urban conditions. The obtained numerical data was processed employing descriptive statistics and analysis of variance (ANOVA) with post hoc Fisher's least significant difference (LSD) test. Compared to the other sampled trees, the progeny of a tree sampled in Zemunski Quay have superior phenotypic characteristics [number of leaves /arithmetic mean \pm standard deviation/ 12.60 ± 1.55 ; seedling height (cm) 18.97 ± 2.57 ; root collar diameter (mm) 5.91 ± 0.93 ; mass of above-ground part (g) 1.40 ± 0.38 ; mass of under-ground part (g) 2.62 ± 0.80], representing a promising source of reproductive material for plant production. ANOVA and LSD show that, in most cases, there are statistically significant differences between the mean values of the analyzed characters, suggesting there is a significant variability among the analyzed genotypes.

Keywords: *Ginkgo*, *morphometric variability*, *plant stock selection*, *urban greenery*, *Belgrade*

Introduction

Maidenhair tree or ginkgo (*Ginkgo biloba* L.) is a dioecious species of gymnosperm, a stenoendemic of the eastern part of China and a secondary wild species in other parts of the country, Japan and Korea. It is the last living species in the order Ginkgoales and the family *Ginkgoaceae*, which first appeared over 250 million years ago. It is a large tree, reaching a height of 40 m and a trunk diameter of up to 2.5 m. Owing to its decorative fan-like two-part leaves which have a characteristic venation and turn deep saffron yellow in autumn, ginkgo is often used as an ornamental tree worldwide, especially in Europe and North America (Vilotić, 2004). Ginkgo is a very suitable tree species for cultivation in shelterbelts, multiple-purpose plantations, and urban conditions (Šijačić-Nikolić et al., 2009). It is classified into the group of most resistant ornamental tree species, tolerating the conditions in urban environments and showing high resistance to low temperatures and pathogens (Vilotić, 2004; Ocokoljić and Grbić, 2009; Ocokoljić et al., 2011). Ginkgo is also efficient in the storage of pollutant

concentrations, which justifies its utilization in urban green areas (Ocokoljić et al., 2011). In addition, its wood is used in the wood industry, leaves for pharmaceutical purposes, and seeds as food or drug (Vilotić, 2004; Šijačić-Nikolić et al., 2009).

On the territory of the Republic of Serbia, ginkgo occurs in green areas mainly as individual trees or in smaller groups, very rarely in tree rows. The origin of the planting stock is not known, but it is assumed that the seeds and seedlings were not brought from Asia and that they are of European origin. There are 55 trees of ginkgo above the age of 100 years that are protected by the law. In the wider area of the city of Belgrade, 94 trees are known to exist (Vilotić, 2004).

As a result of its multiple benefit value, this species has been increasingly studied in Serbia in the past 20 years (e.g., Vilotić, 2004; Knežević and Tucović, 2005; Šijačić-Nikolić et al., 2006a, 2006b, 2009; Ocokoljić and Grbić, 2009; Jovanović, 2010; Ocokoljić et al., 2011). The study of individual variability of trees has considerable significance for genetic studies, whose results could be applied to the production of nursery stock (Stilinović and Tucović, 1975). Ecological adaptability can also be confirmed by morphologically variable characteristics (Lavadinović and Marković, 2012) and the variability of seedling characters can be the indicator of further seedling development, which emphasizes the significance of such research for the advancement of the technology of plant production (Šijačić-Nikolić et al., 2009). Bearing in mind the aforementioned information, this paper analyzes several morphological traits and growth elements of two-year-old ginkgo seedlings in the test with seven half-sib lines sampled from green spaces of Belgrade city, in order to provide the basis for planting stock selection and the establishment of plantations adapted to urban conditions.

Materials and Methods

Depending on the yield quantity, seven mother trees appearing individually on five green areas of Belgrade city were selected (Table 1; Fig. 1) and used as seed sources for the establishment of the experiment and the production of half-sib progeny. After preparation, the seeds were sown in plastic tubs ("Plantagrah") in a mixture of peat, sand and forest humus (2:2:1). During winter and early spring, the tubs were stored in the greenhouse of the Nursery of the Faculty of Forestry, University of Belgrade, and transferred to the open in May. Applying intensive tending measures, the seedlings were grown in containers placed on a flat surface in seclusion, at an altitude of 127 m (44°46'59"N, 20°25'31"E).

Table 1. Analyzed ginkgo mother trees on green spaces in Belgrade city.

Tree mark	Site	Coordinates
T1	Zemun Quay	44°50'35"N, 20°25'01"E
T2	Zemun Quay	44°50'35"N, 20°25'01"E
T3	Zemun Quay	44°50'35"N, 20°25'01"E
T4	Tasmajdan Park	44°48'35"N, 20°28'14"E
T5	Kalemegdan Park	44°49'12"N, 20°27'06"E
T6	Jevremovac Botanical Garden	44°48'53"N, 20°28'26"E
T7	Park Milutin Milankovic	44°47'55"N, 20°27'51"E

Seedling analysis was performed at the end of the second vegetation period on the sample of 15 individuals per half-sib line, covering the variability of the following growth elements and morphometric characters: root collar diameter (mm), seedling height (cm), number of leaves, mass of above-ground part (g), and mass of below-ground part (g). The obtained numerical data was processed employing descriptive and univariate statistical methods. The descriptive statistics included determining the following statistical parameters: minimum value (MIN), maximum value (MAX), mean value (\bar{X}), standard deviation (\pm SD), and coefficient of

variation (CV, %). The statistical significance of differences between the mean values of the analyzed seedling characters was determined by analysis of variance (ANOVA) with post hoc Fisher’s least significant difference (LSD) test. All statistical analyses were performed using Statgraphics Centurion ver. XVI.I (2009; Statpoint Technologies, Inc., Warrenton, VA).



Fig. 1. Some of the analyzed ginkgo mother trees on green spaces of Belgrade city and the analyzed seedling characters: (a) Zemun Quay (trees T2, T3, and T1) (photo: Šijačić-Nikolić M., 2005); (b) Park Milutin Milankovic (tree T7) (photo: Jovanović F., 2005); (c) seedling morphometric characters (height, root collar diameter, mass of above-ground part, mass of under-ground part, and number of leaves).

Results and Discussion

The results of the statistical analysis of morphometric characters and growth elements of two-year-old ginkgo seedlings, grown from seed collected in green spaces of Belgrade city, are presented in Table 2 and Fig. 2. Seven half-sib lines were analyzed in this study, but given that the seed germination percentage of tree T2 was insufficient for seedling sampling, the statistical analysis covered the remaining six half-sib lines. It was found that all analyzed seedling characters (except for the mass of the under-ground part) of tree T1 have the highest mean values, and all analyzed seedling characters of tree T3 have the lowest mean values (Table 2; Fig. 2). ANOVA and LSD show that, in most cases, there are statistically significant differences between the mean values of the analyzed characters (excluding root collar diameter) (Table 2), suggesting there is a significant variability among the analyzed genotypes based on the seedling characters at the end of the second vegetation period. In other words, for the most analyzed characters, the progeny of T1 was superior in comparison to the progeny of the other sampled trees. According to literature (Šijačić-Nikolić et al., 2009; Jovanović, 2010), the same mother tree, along with T7, had the highest germination percentage and the highest mean values of all seedling characters in the juvenile phase of development, which makes this tree a promising source of seed material for plant production. On the other hand, the poor germination percentage of T2 may be the consequence of poor pollination due to the distance and the lower number of male individuals compared to female individuals on the sampling site in Zemun Quay (Šijačić-Nikolić et al., 2006a). The best

indicators of seedling quality are seedling height, root collar diameter, root length, and the ratio of seedling under-ground part to above-ground part (Stilinović, 1987, 1991), which are conditioned by the genetic constitution of mother trees, the presence of sufficient amount of pollen, the compatibility of parent genotypes, and the environmental conditions in the year of seed formation (Stilinović and Tucović, 1975). Taking into account the presented statistical results and the fact the seedlings were grown in the same environment conditions, the factor of environmental impact can be eliminated and the resulting morphometric variability can be considered as the result of the differences in genotypes.

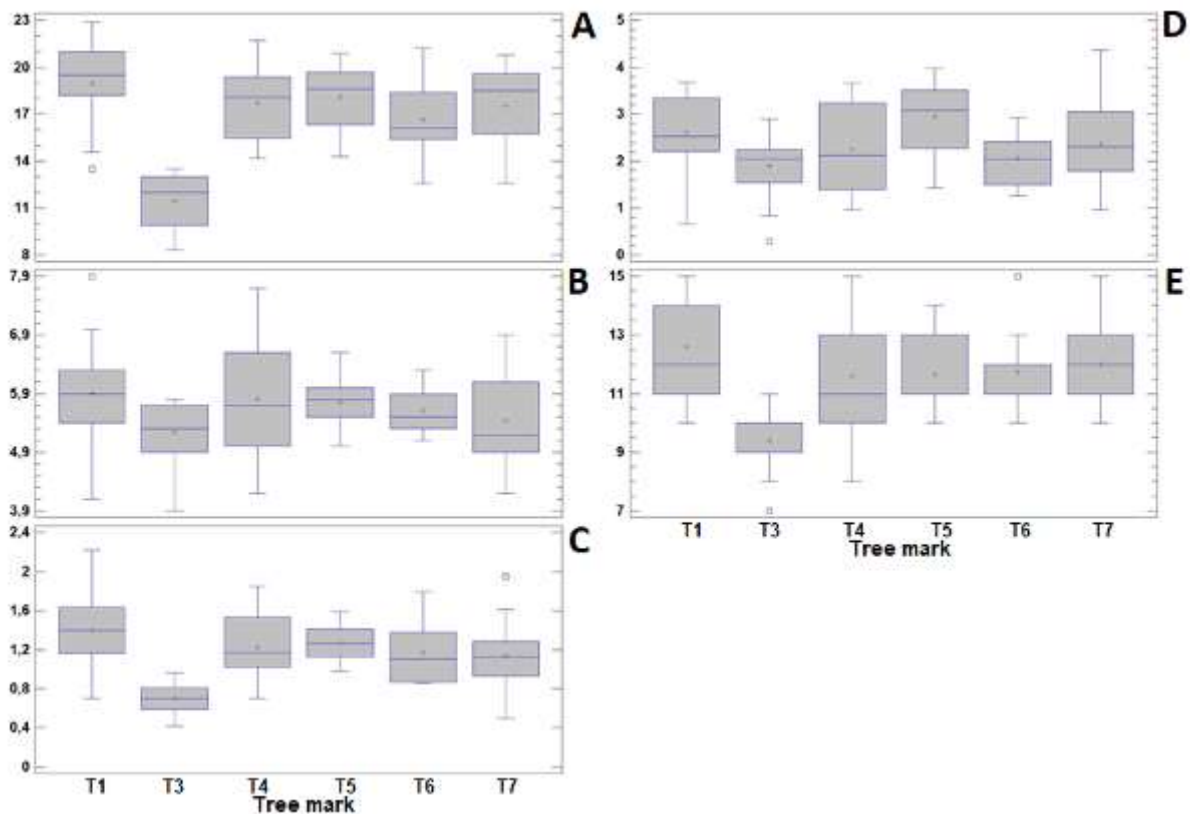


Fig. 2. Box and whisker plots of basic parameters of seedling morphometric characters: (A) seedling height (cm); (B) root collar diameter (mm); (C) mass of above-ground part (g); (D) mass of under-ground part (g); (E) number of leaves. Legend: middle sign = mean, middle line = median, box = mean and standard deviation, whisker = variation range.

The genetic potential of ginkgo mother trees was assessed by the analysis of morphometric traits of their progeny in the two-year stage of development, aiming at the improvement of reproductive material by the detection of superior genotypes. The obtained results conform to the observations made on the progeny of the same trees in the juvenile phase of development (Šijačić-Nikolić et al., 2009; Jovanović, 2010), confirming that there is a significant genetic variability among the analyzed genotypes. The analyses included the quantitative characters controlled by polymer genes, i.e., numerous multiple genes whose effects are added. As father trees are unknown, because the reproduction material originated from free pollination, it can be argued that mother tree T1 has a good genetic constitution given that the results of the analyzed characters were repeated in its half-sib progeny during two successive vegetation periods. Since comparative analysis of seedlings from half-sib lines enables the identification of the planting stock which is significant for further propagation (Ocokoljić et al., 2011), the results of this study can serve as the base for the selection of mother trees which could be the

source of reproductive material for the production of seedlings with targeted characteristics and the establishment of plantations adapted to urban conditions.

Table 2. Statistical analysis of seedling morphometric characters of six ginkgo mother trees.

Tree mark		Seedling height (cm)	Root collar diameter (mm)	Mass of above-ground part (g)	Mass of under-ground part (g)	Number of leaves
T1	\bar{X}	18.97 a	5.91 a	1.40 a	2.62 ab	12.60 a
	MIN	13.50	4.10	0.70	0.65	10
	MAX	22.90	7.90	2.22	3.68	15
	SD	2.57	0.93	0.38	0.80	1.55
	CV%	13.54	15.81	27.03	30.74	12.30
T3	\bar{X}	11.45 c	5.24 b	0.70 c	1.90 c	9.40 b
	MIN	8.30	3.90	0.42	0.30	7
	MAX	13.50	5.80	0.96	2.89	11
	SD	1.67	0.58	0.16	0.67	1.06
	CV%	14.55	11.12	23.11	35.08	11.23
T4	\bar{X}	17.71 ab	5.81 a	1.23 ab	2.25 bc	11.60 a
	MIN	14.20	4.20	0.70	0.96	8
	MAX	21.70	7.70	1.85	3.67	15
	SD	2.39	0.92	0.33	0.94	2.03
	CV%	13.48	15.94	27.06	41.85	17.49
T5	\bar{X}	18.09 ab	5.75 ab	1.26 ab	2.95 a	11.67 a
	MIN	14.30	5.00	0.98	1.43	10
	MAX	20.90	6.00	1.59	3.97	14
	SD	2.01	0.46	0.16	0.77	1.29
	CV%	11.09	8.02	12.92	26.05	11.07
T6	\bar{X}	16.63 b	5.61 ab	1.17 b	2.06 bc	11.73 a
	MIN	12.60	5.10	0.86	1.26	10
	MAX	21.20	6.30	1.79	2.94	15
	SD	2.31	0.38	0.31	0.53	1.28
	CV%	13.91	6.69	26.21	25.47	10.91
T7	\bar{X}	17.49 ab	5.44 ab	1.14 b	2.36 bc	12.00 a
	MIN	12.60	4.20	0.50	0.96	10
	MAX	20.80	6.90	1.95	4.36	15
	SD	2.48	0.76	0.34	0.92	1.36
	CV%	14.17	13.96	29.55	39.03	11.36
ANOVA	F	21.38	1.86	9.85	3.54	8.39
	p	0.0000	0.1102	0.0000	0.0059	0.0000

*Note: Boldfaced values denote variables with $p < 0.05$ and any two means within a column not followed by the same letter(s) are significantly different at the corresponding confidence level.

Conclusion

Based on the results of the morphometric analysis of two-year-old ginkgo seedlings grown from the seed material collected in the urban green areas of Belgrade city, it can be concluded that the differences between the mean values are statistically significant for almost all analyzed characters, except for root collar diameter.

Considering the fact that the experimental conditions were homogenous, it can be concluded that the established differences between the progeny of the analyzed ginkgo mother trees are of a genetic nature. This research of progeny at the two-year stage of development confirms the presence of major genetic variability. Most of the analyzed characters have a quantitative character and it is governed by polymeric genes whose effect is additive. The highest mean values of seedling morphometric characters and growth elements were assigned to the

progeny of tree T1, originating from Zemun Quay. Possessing a high genetic potential, this mother tree represents a promising source of seed material for seedling production.

The results of the study should be considered significant information in selecting mother trees for sourcing reproductive material for plant production and the establishment of plantations adapted to urban conditions.

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AUTHOR INDEX

Abd El Basset BOUKHOUNA.....	704	Antal SZŐKE.....	536
Abdel KADER EL HAJJ.....	570	Antonela MUSA.....	666
Abdel Kader NAINO JIKA.....	187	Antonije ŽUNIĆ.....	556, 630
Abdellatif NIAR.....	993	Armands KVIESIS.....	1076
Abdourahmane AMADOU BOUBACAR.....	187	Ashraf KABAR.....	827, 836
Abdullah BEYAZ.....	408, 415	Asimina-Georgia KARIDA.....	165
Adrian ASANICA.....	752	Asimina-Georgia KARYDA.....	46, 134, 383
Adriana KUŠNIER PALUGOVÁ.....	576	Atakan GÜNEYLİ.....	430
Adriana RADOSAVAC.....	247, 1154	Athanasios BATZIOS.....	1200
Ahmed MOUSSA.....	730	Athanasios TSAFOUROS.....	29, 112, 397
Aiga NOLBERGA-TRŪPA.....	1057	Athina TEGOU.....	140
Aija MĀLNIECE.....	1057	Attila BOROVIĆ.....	1292
Aivars POĻAKOVŠ.....	1057	Attila FŰRÉSZ.....	536, 807, 1094
Aldjia KHERCHOUCHE.....	976	Aykut ÖRS.....	888
Aleksandar ĐIKIĆ.....	333	Ayşe Gul NASIRCILAR.....	423, 452, 470
Aleksandar IGNJATOVIĆ.....	1065	Ayşegül SARISU.....	430
Aleksandar KOVAČEVIĆ.....	195	Aysun YENER ÖĞÜR.....	888
Aleksandar LUČIĆ.....	1357	Aziz HAFFERSSAS.....	976
Aleksandar PAUNOVIĆ.....	226	Azra ČABARAVDIĆ.....	1278, 1285
Aleksandar PETROVIĆ.....	653	Bahadır ŞİN.....	542
Aleksandar RADOVIĆ.....	234	Baran KAYNAK.....	542
Aleksandar Sandro CVETKOVIĆ.....	787	Bekri XHEMALI.....	712
Aleksandar VUKOVIĆ.....	240, 333, 487	Belmehel BENSAHLI.....	984, 988, 993
Aleksandra ANGELESKA.....	600	Bence BALÁZS.....	697
Aleksandra GOVEDARICA-LUČIĆ.....	51, 642	Betim BRESILLA.....	712
Aleksandra JEVTIĆ.....	941	Biljana PEĆANAC.....	586, 1086
Aleksandra KORIĆANAC.....	220	Biljana SEVIC.....	203
Aleksandra ŠUŠNJAR.....	556, 630	Biljana VELJKOVIĆ.....	280, 1218
<i>Aleksandra TASIĆ</i>	622, 1045	Bisetsa ERICKSON.....	1146
Aleksandra Yu. NOVOSELSKAYA- DRAGOVICH.....	226	Boban ĐORĐEVIĆ.....	262
Aleksejs ZACEPINS.....	1076	Bodan ANDONOV.....	1265
Alexander M. KUDRYAVTSEV.....	226	Bogdan NEDIĆ.....	635
Alexander USATOV.....	1006	Bojan GOLIC.....	586, 1086
Alexandros KAKOURIS.....	1200	Bojana ĆURKOVIĆ.....	635
Alexandros THEODORIDIS.....	1200	Bojana KOMAROMI.....	324
Alhassane Gousmane AHMED.....	187	Bojana VUKOVIĆ.....	635
Ali AYGUN.....	931, 936	Boris ADAMOVIĆ.....	494, 507
Ali AYGÜN.....	1115	Boris RILAK.....	212, 353, 371
Ali ÖZTOP.....	686	Boryana DYULGEROVA.....	118
Alireza MOHEBALI.....	813	Boško GAJIĆ.....	310
Alpay BALKAN	436, 444	Branislav DRAŠKOVIĆ.....	769
Amrosi CHKUASELI.....	1120	Branka GOVEDARICA.....	63, 89
Ana DRAGUMILO.....	648	Branka KRESOVIĆ.....	310
Ana GARCIA-RODRIGUEZ.....	864, 869	Branka PAVLOVIĆ.....	1344
Ana GARCÍA-RODRÍGUEZ.....	908	Branka TRIFUNOVIĆ.....	513
Ana KNEŽEVIĆ.....	780	Brankica PEŠIĆ.....	550
Ana NIKOLIĆ.....	346	Branko MIHAILOVIĆ.....	500
Ana VELEMIR.....	740	Branko POPOVIĆ.....	220
Andrei CHIRILOAIE-PALADE.....	672	Bratislav ĆIRKOVIĆ.....	255
Andrej PILIPOVIĆ.....	1339	Bratislav PEŠIĆ.....	941
Andrijana ANDRIĆ.....	1317	Carolina BOIX FAYOS.....	1238
Andromachi ROUMELIOTI.....	145	Cennet OĞUZ.....	888
Angel SAROV.....	1172	Cristian TERRADOS-LOPEZ.....	864
Angela CIVIDINI.....	1139	Csaba LANTOS.....	536
Angelina PETKOVIĆ.....	1213	Cyril HRNČÁR	1039
Anja VUKSAN.....	718	Dalibor TOMIĆ.....	513
Anna KOSTA.....	112	Damla Balaban GÖÇMEN	436
		Damla BALABAN GÖÇMEN.....	444

Danica MIĆANOVIĆ	247, 359	Dušanka VUJANOVIĆ	1317
Dániel BALOGH	536, 807	Dušica ĆIRKOVIĆ	255
Danijela ĐUNISIJEVIĆ-BOJOVIĆ... 130, 178, 403		Dženita KOCA	268
Danijela KONDIĆ	226, 563	Eduard MAURI	800
Danijela PETROVIĆ	666, 774	Eduard PLANA	800
Danijela RISTIĆ	287, 346	Efstathios NTANOS	29, 112, 397
Danijela SKROZA	101	Efthalia STATHI	112
Danijela ŽUNIĆ	519	Elena GARRACHON-GOMEZ	864, 869
Danka MITROVIĆ	653, 718	Elena GARRACHÓN-GÓMEZ	908
Dario ILJKIĆ	124	Eleni TANI	112
Dariusz KOKOSZYŃSKI	1039	Eleni WOGIATZI	140
Darko UHER	475	Elif BABACANOĞLU ÇAKIR	1010
David GONZALEZ-PEÑA	869	Elizabeta DIMITRIESKA STOJKOVIK	600
Davide GIOVANARDI	712	Elma SEFO	56
Dejan ĐUROVIĆ	262	Elsa VALÉRIO	876
Dejan SOKOLOVIĆ	340, 1127	Emel KAÇAL	430
Dejan ZEJAK	75	Emilio STEFANI	712
Dejana STANIĆ	613	Emina ADEMOVIĆ	780
Desimir KNEŽEVIĆ ..226, 247, 304, 318, 359, 563, 1154		Emre ALARSLAN	1132
Despina POPOVSKA STOJANOV	1265	Enika GREGORIĆ	268
Diego. GRANADOS-LOPEZ	864	Erika REMEŠICOVÁ	576
Dilek KARAMÜRSEL	430	Éva Ilona KIRÁLY	1292
Dimitrios BARTZIALIS	140, 145, 150, 157	Eva WEISBAUEROVÁ	795
Dimitrios ZARIFOPOULOS	383	Evangelia AVRAMIDOU	800
Dimitris C. GKIKAS	900	Fatbardha SHPATI	34
Dobrila RANĐELOVIĆ	859	Fatemeh BORNA	1207
Dobrivoj POŠTIĆ	378	Fatma Pınar ÖZTÜRK	430
Dogan NARINC	931, 936	Fawzi KODIH	827, 836
Doğan NARİNÇ	1115	Ferenc PAJOR	1094
Đorđe BOŠKOV	234, 262	Feyza Tahan ÇAY	436
Đorđe ILIĆ	642	Filip BEKČIĆ	274, 607
Đorđe LAZAREVIĆ	513, 1109	Filip JOVANOVIĆ	594
Đorđe VOJNOVIĆ	494, 507	Francesco MODICA	712
Dragan BOŽOVIĆ	318	Gabriella KEMÉNY	807
Dragan GRČAK	304, 563	Ganganee Chandima SAMARAWEEERA	1362
Dragan KNEŽEVIĆ	586, 1086	Gavriil XANTHOPOULOS	800
Dragan MILATOVIĆ	234, 262	Gazmend GJINOVCİ	712
Dragan VUJIČIĆ	846, 853	Georgia KOUTOUZIDOU	1200
Dragan ŽIVANČEV	304	Géza KIRÁLY	1299
Dragan ŽNIDARČIĆ	390	Giorgi KHATIASHVILI	1120
Dragana BARTOLIĆ	299	Gisaro Ca- Madeberi Ya BITITI	1146
Dragana BOŠKOVIĆ	556, 630	Gökhan ÖZTÜRK	430
Dragana IGNJATOVIĆ-MICIĆ	287	Goran ČEŠLJAR	1333
Dragana KNEŽEVIĆ	51	Goran JEVTIĆ	340, 1065, 1109
Dragana LALEVIĆ	240, 333, 487	Goran MARINKOVIĆ	1272
Dragana SKOČAJIĆ	130, 178, 403	Goran MIRJANIĆ	1065
Dragana STANISAVLJEVIĆ	255, 859	Goran SRDIJA	769
Dragana ŠUNJKA	556, 630	Goran VUČIĆ	740
Dragana VUKOVIĆ	642	Gordan ZEC	234, 262
Dragica GAGOVIĆ	51	Gordana BABIĆ	635
Dragica VOJNOVIĆ	1045	Gordana MATOVIĆ	268
Drago BEŠLO	968, 1033	Gordana PETROVIĆ	1154
Dragoş Florin MANEA	955	Grace NELKAM KILABÉ DJIMADOUM	187
Dragoslav ĐOKIĆ	487	Hamid Asım ÇÖKREN	542
Đurđa PETROV	846, 853	Hamissou AMADOU MOUNKAILA	187
Dusan ANDRIJASEVIC	1051	Hasan ARISOY	936
Dušan JOKANOVIĆ	1305, 1311	Hassib BEN KHEDHER	730
Dušan PAROŠKI	494	Helena BREKALO	666, 774
Dušan UROŠEVIĆ	247, 318, 359	Hossein AZADI	1207
		Ignacio GARCIA	869

Igor ĐURĐIĆ.....	63, 365	Katarina GAJIĆ	310
Igor ESMEROV	600	Katarina PANDŽIĆ	968, 1033
Igor V. GONCHARENKO	926	Katica RADOSAVLJEVIĆ.....	500
ikoleta-Kleio DENAXA.....	29	Kazimir MATOVIĆ.....	1109
Ilias MICHALAKIS.....	140	Khaled A. ABBAS.....	915
Iman IBRAHIM	827, 836	Khaled DJELOUAH	761
Iman ISLAMI.....	1207	Kirill NAROZHNYKH.....	948
Innocent MUMARARUNGU	1146	Konstantina-Maria KOTSARINI	145
Ionuț-Cristian POPA	672	Kristina Ilektra MAKNEA.....	752
Ippolitos GINTSIOUDIS	145, 150, 157	Kristina ŽIVANOVIĆ	1305, 1311
Irena PUGELNIK	746	Ksenija RADOTIĆ	299
İrfan NAZLI.....	430	Kyriakos D. GIANNOULIS	140, 145, 150, 157
Irina SFECLA	820	Ladislav VASILIŠIN	740
Ismet BAŞER	436	László MAJOR	697
İsmet BAŞER.....	444	László SIPOS.....	1094
Iva UZELAC.....	563	Lazo DIMITROV.....	1265
Ivan DESIMIROVIĆ	1305, 1311	Leona PULJIĆ	1071
Ivan GLIŠIĆ.....	212	Levente VISZLÓ	807
Ivan HORVATIĆ.....	475	Lidija MILENKOVIĆ.....	240
<i>Ivan PAVLOVIĆ</i>	622, 1045	Lilia MELLAK	976
Ivan UROŠEVIĆ	220	Ljiljana DRINIĆ	1232
Ivana BAKIĆ	262	Ljubinko RAKONJAC.....	594, 1357
Ivana BOŠKOVIĆ	69	Ljubomir ŽIVOTIĆ	310
Ivana GLIŠIĆ.....	657	Ljupco ANGELOVSKI	600
Ivana JASNIĆ	304	Lucia MIŠUROVÁ	576
Ivana MILETIC	75	Luis SANTA MARIA.....	962
Ivana PLAVŠIĆ JANJATOVIĆ	653	Luka DRENJANČEVIĆ	124
Ivana VARGA	124	Lutvija KARIĆ	56
Ivana ŽIVANOVIĆ.....	594	Lyubov GETMANTSEVA	1006
Ivana ZLATKOVIĆ.....	859	Mădălina RĂDULEA	672
Ivica KOSTIĆ.....	274	Mahaman Rabiou HACHIMOU SABO.....	187
Jana RAMMAL	570	Maja AROK.....	1317
Jasmina BAČIĆ	318	Maja ŽIVANOVIĆ	550
Jasmina MILENKOVIĆ	340	Malghaha Gamage Dilshani ABEYSINGHE ..	1362
Jasmina RADOVIĆ.....	340, 607, 1127	Malika MEZIANE	761
Jelena EĆIMOVIĆ.....	556	Manjala DE ZOYSA	1362
Jelena JOVIĆ	1317	Manuel GARCÍA-FUENTE	908
Jelena NIKITOVIĆ.....	1051, 1102	Mara BANOVIĆ	101
Jelena TOMIĆ.....	212, 353, 371	Maria GODINHO	876
Jelena VANČETOVIĆ.....	287	Maria IAMANDEI.....	672
Jelica ŽIVIĆ.....	247	Marica PETROVIĆ.....	324
Jemal KHATIASHVILI.....	1120	Marija BAJAGIĆ	365
John A. THEODOROU	900	Marija GAVRILOVIĆ.....	280, 1218
Jordan MARKOVIĆ	274	Marija GJOSHEVA KOVACHEVIKJ	1265
José de Jesus Sousa LEMOS.....	1255	Marija KOSTADINOVIĆ.....	287
Josip STANIĆ.....	124	Marija MARKOVIĆ	41, 107, 130, 178, 294, 403
Jovan BOJKOVSKI	1045	Marija MIHALJEV	883
Jovan PAVLOV	195	Marija MILETIC GLISIC	999
Jovana DEVETAKOVIĆ.....	1305	Marija MILIČIĆ.....	1317
Jovana HRUSTIĆ	550	Marija NEŠIĆ	130, 178, 403
Jovana KOVAČEVIĆ.....	63	Marija PAVLOVIĆ.....	1045
Jovana PRIJIĆ.....	635	Marija STEPIĆ	274, 607
Jovanka POPOV – RALJIĆ.....	722	Marijana NOVAKOVIĆ-VUKOVIĆ	1324
Jozef BUJKO	1039	Marijana PEŠAKOVIĆ.....	212, 371
József LEHEL	697	Marina CORTIELLO.....	712
Juraj CANDRÁK.....	1039	Marina MARINIĆ.....	124
Kamenko BRATKOVIĆ.....	318	Marina MILOVIĆ.....	1339
Kamile ULUKAPI	423, 452, 470	Marina NONIĆ	1305
Károly PENKSZA.....	536, 807, 1094	Mário DUARTE.....	876
Katarina ĐURIĆ	1225	Marios C. GKIKAS	900

Mariusz BOGUCKI	1039	Miroslava MARKOVIĆ.....	1333
Marko BOŽIĆ	1272	Mirsada STARČEVIĆ	1278, 1285
Marko JAUKOVIĆ	718	Mirta RASTIJA.....	124
Marko MLADENOVIĆ	195	Mistral VAN OUDENHOVE	1238
Martin DĚDINA	795	Mladen PETROVIĆ.....	365
Martina KOVAČEVIĆ	475	Mohamed BRAHAM.....	730
Martina SALOVA.....	1186	Mohamed MAHMOUDI	704
Mate BOBAN	774	Mohammed Gamal ABDELAZIZ ALI.....	458
Mazen MOHAMED BARAKAT	1193	Mohsen JANMOHAMMADI	182
Medine KAYA.....	1115	Moma DENIĆ.....	859
Mehmet KEÇEÇİ.....	686	Monika SABEVA	1180
Mehmet Reşit KARAGEÇİLİ.....	1010	Nadhirah Binti SAIDON.....	697
Melih AYDINLI	430	Naser SABAGHNIA.....	182
Metehan KAZANCI.....	415	Nasser Abu GALWA.....	827
Mihajlo LIZDEK	75	Nasser Abu GHALWA.....	836
Milan BIBERDŽIĆ	240, 333, 487	Nassima BOUHROUM	984, 988, 993
Milan JUGOVIC	89	Natalia-Maria METAXA	145
Milan JUGOVIĆ	69	Natalija MOMIROVIĆ	594, 1333
Milan LUKIĆ.....	212	Nataša DUDUK	607
Milan P.PETROVIĆ	1045	Nataša VUKELIĆ	1232
Milan PUZIGACA.....	1051	Nebojša NEDIĆ	1065, 1109
Milan STEVANOVIĆ.....	195	Nebojša NOVKOVIĆ	1232
Milan UGRINOVIĆ.....	41, 107	Nebojša ZLATKOVIĆ.....	941
Milana STOJANOSKI	234, 262	Neda ORAŠANIN MILAKOVIĆ.....	130, 178, 403
Milena ĐORĐEVIĆ.....	657	Nedeljka ELEZ	1163
Milena SIMIC	203	Nedeljko RACIĆ.....	274, 1127
Milena SIMIĆ	378	Nemanja TEŠIĆ	234
Milenko BLESIĆ	94	Nenad DELIĆ	195
Milica ALEKSIĆ	722	Nenad DJURIC	203
Milica BOSNIĆ	82	Nenad ĐURIĆ.....	365
Milica GRUBAČIĆ.....	51	Nenad PAVLOVIĆ.....	513
Milica MIHAJLOVIĆ.....	550	Nenad POPOV	883
Milica NIKOLIĆ.....	346	Nesreen M. NASR	915
Milica STOJANOVIĆ.....	51	Nevena RISTIČEVIĆ	63
Milica ŽIVKOV BALOŠ.....	883	Nevenka GALEČIĆ	846, 853
Milomir FILIPOVIĆ	346	Nicholaos G. DANALATOS	140, 145, 150, 157
Milomirka MADIĆ	513	Nikola STOLIĆ.....	941
Miloš MARJANOVIĆ	513	Nikolay DYULGEROV	118
Miloš PETROVIĆ.....	630	Nikoleta-Kleio DENAXA.....	112, 172, 397
Miloš PROKOPIJEVIĆ	299	Nikolina ĐEKIĆ	82
Miloš STANKOVIĆ	365	Nikolina ŽIVKOVIĆ	653
Miloš ZELIĆ.....	280	Ninoslav NIKIČEVIĆ.....	220
Milosav GRČAK	304, 563	Numan ÇELEBİ.....	542
Milun D. PETROVIĆ	1218	Ogulcan KARA.....	452
Milutin ĐILAS.....	1339, 1351	Oğuz BILGIN	436
Miodrag DIMITRIJEVIĆ	226	Oğuz BİLGİN	444
Miodrag RADOVANOVIĆ	1351	Olga MITROVIĆ	220
Miodrag TOLIMIR	310	Olivera ŠUŠA	240
Mira STANKOVIĆ.....	299	Olvija KOMASILOVA.....	1076
Mirela MATKOVIĆ STOJŠIN...226, 247, 318, 359		Omer EREN	931
Mirela TOMAŠ SIMIN.....	324	Ömer Faruk KARAMÜRSEL.....	430
Mirjam VUJADINOVIĆ MANDIĆ	268	Orsolya SZABÓ.....	1292
Mirjana JOVOVIĆ.....	642	Osman AYDENİZ	464
Mirjana LUKAČ BULATOVIĆ	1225	Ozlem SAHIN.....	470
Mirjana OCOKOLJIĆ.....	846, 853	Pavel ČERMÁK	795
Mirjana PETROVIĆ	1109, 1127	Pedro PÉREZ CUTILLAS.....	1238
Mirjana RADOVIC.....	75	Pero MIJIĆ.....	968, 1033
Mirjana ŽABIĆ	82	Peter A. ROUSSOS 29, 46, 112, 134, 165, 383, 397	
Mirko KULINA	75	Péter BUDAI.....	697
Miroslav MARKOVIĆ	1339	Péter PENKSZA	1094

Peter STRAPÁK	1039	Snežana OLJAČA	378
Petr JEVIC	795	Snežana STAJIC	1333, 1344
Petros A. ROUSSOS	172	Sofija PETROVIC	226
Philippe BURNY	1146	Sol GARCIA-RODRIGUEZ.....	869
Predrag IVANKOVIĆ.....	1071	Sol GARCÍA-RODRÍGUEZ.....	908
Predrag PAP.....	1339	Sol. GARCIA-RODRIGUEZ.....	864
Predrag PERIŠIĆ	1065	Sonja BRAUNOVIĆ.....	594
Rade STANISAVLJEVIĆ	487	Srdan ŠEREMEŠIĆ	378
Radivoje JEVTIĆ.....	304	Srdjan LJUBOJEVIĆ.....	740
Radmila CRCEVA NIKOLOVSKA	600	Sreten ANDONOV	1265
Radosav CEROVIĆ	657	Stefan GORDANIĆ	648
Radoslav LOZJANIN	1311	Stevan RAJIC	1102
Raluca GEORGESCU.....	672	Stylios GIANNOULIS	145
Ranko KOPRIVICA	280, 1218	Suzana TREŠNJIĆ IVANOVIĆ	576
Renata GAGIĆ-SERDAR.....	1333	Svetlana BOGDANOVIĆ	859
Reza ERFANZADEH.....	813	Svetlana JERINIĆ.....	1127
Ridvan KIZILKAYA	458	Svetlana M. PAUNOVIĆ.....	212, 353, 371
Rita SZABÓ.....	697	Svjetlana JANKOVIĆ-ŠOJA.....	1213
Rosa Santos COELHO.....	876	Tamar QACHASHVILI.....	1120
Ružica ĐERVIDA.....	1154	Tamás MOLNÁR.....	1299
Samir ALI-AROUS.....	761	Tamás MOLNÁR.....	1292
Sandra JAKŠIĆ	883	Tamaz BICHIASHVILI	481
Sandra MEDIĆ.....	666	Tanja BIJELIĆ	622
Sandra MOJSOVA.....	600	Tanja JAKISIC	89
Sanja JOVANOVIĆ	1357	Tanja JAKIŠIĆ	63, 69
Sanja LAZIĆ	556, 630	Tanja VASIĆ	274
Sanja PERIĆ	195	Tanja VUCIC.....	999
Sanja RADIČEVIĆ	220, 657	Tatjana IVANOVIĆ.....	1154
Sara MIKIĆ.....	648	Tatjana JOVANOVIĆ-CVETKOVIĆ	94
Saša BARAĆ	240, 333, 487	Tatjana KRAJISNIK.....	1051, 1102
Saša KOSTIĆ.....	1339	Tatjana MARKOVIĆ.....	648
Saša LALIĆ	1245	Tatjana STEVIĆ.....	648
Saša MATIJAŠEVIĆ	255	Tetiana IVANOVA	528
Saša PEKEČ	1339	Thalia BATRA.....	157
Saša PEŠEV	941	Tihomir ŠOŠKIĆ	1311
Saša PETROVIĆ.....	255	Tijana BANJANIN	94
Sasho KJOSEV	1265	Tina BOBIĆ.....	968, 1033
Selena CEVRIZ	89	Tomáš LOŠÁK	795
Selena ČEVRIZ	69, 642	Toni GALIĆ.....	774
Selin ŠİMŞEK.....	452	Turgut AYGÜN	1015, 1021, 1027, 1132
Selman CHABANI	976	Turkan MUTLU KECELI.....	582, 678, 682
Sevinç BAŞAY	464	Vagis SAMATHRAKIS	1200
Shadi HAZHIR	813	Valters BRUSBARDIS	1076
Shalva BICHIASHVILI.....	481	Vanja TATIĆ.....	563
Simeon RAKONJAC	1218	Varvara SHEVTSOVA.....	1006
Slađan TRIŠIĆ	613	Vasile MACIUC	955
Slađana JANKOVIĆ	63	Vassilios KAIBALIS	165
Slađana SAVIĆ	359	Vele TEŠEVIĆ	220
Slavica ČABRILO	722	Velisav KARAKLIĆ.....	1351
Slavica ČOLIĆ.....	657	Veljko ŠARAC	1232
Slavica VUKOVIĆ	556, 630	Vera RAJIČIĆ.....	304
Snežana ANĐELKOVIĆ.....	340, 1109	Vera RAKONJAC	657
Snežana ANDJELKOVIĆ.....	607	Veroslava KOCIĆ.....	255
Snežana BABIĆ	340, 607, 1109	Veselinka ZEČEVIĆ.....	226, 318, 359
Snezana DJORDJEVIC.....	203	Vesna DRAGICEVIC.....	203
Snežana ĐORĐEVIĆ.....	378	Vesna KANDIĆ	247
Snežana GOŠIĆ-DONDO.....	563	Vesna MILIC	89
Snezana JOVANOVIĆ	999	Vesna MILIĆ	63
Snežana MLADENOVIĆ DRINIĆ.....	346	Vesna NIKOLIĆ JOKANOVIĆ	1305, 1311
Snežana MRĐAN	648	Vesna PERIĆ	287

Vesna POČUČA	268	Žarko NESTOROVIĆ.....	1272
Vesna POPOVIĆ	500	Zbynek ULČAK.....	1186
Vesna RADOJČIĆ	787	Zdenko IVKIĆ	968, 1033
Vesna ŽUPANSKI.....	304	Željana PRIJIĆ.....	648
Vicky CHRISTOPOULOU.....	46	Željko D. POPOVIĆ	563
Vida TODOROVIĆ	82	Zeljko DOLIJANOVIĆ	203
Violeta Alexandra ION	752	Željko DOLIJANOVIĆ	378
Violeta ANĐELKOVIĆ.....	346	Željko KAITOVIĆ.....	310, 346
Violeta CARAO PETROVIĆ	1045	Željko MIHALJEV	883
Višnja SIKIMIĆ.....	722	Zine Eddine LABDAOUI	704
Vitalijs KOMASILOVS.....	1076	Živko SKRAČIĆ.....	101
Vladan POPOVIĆ.....	1357	Zlatko SVEČNJAK.....	475
Vladeta STEVOVIĆ	513	Zoran BEŠLIĆ.....	255
Vladimir FILIPOVIĆ	648	Zoran GALIĆ.....	1351
Vladimir SABADOŠ.....	519	Zoran ILIĆ	1272
Vladimir ZORNIĆ	274, 1127	Zoran JOVANOVIĆ	255
Vlado ČOKEŠA	1344	Zoran LUGIĆ.....	340, 607, 1127
Vojin CVIJANOVIĆ.....	365	Zoran MALETIĆ	1051
Vojislav STOJŠIN.....	359	Zoran PODUŠKA	1344
Vojislav TRKULJA	635	Zoran S. ILIĆ.....	240
Walaa M. BAHNAS	915	Zoran SRDIJA	769
Yamina GUENAOU I.....	704	Zoranka MALEŠEVIĆ	69, 642
Yimeng ZHANG.....	894	Zorica GOLIĆ.....	1163, 1245
Yuanyuan YI.....	894	Zorica RANKOVIĆ-VASIĆ.....	94
Yuri KOLOSOV	1006	Zrinka KNEZOVIĆ	56, 101, 1071
Yusuf ÇELİK.....	888	Zrinko MIKIĆ.....	968, 1033
Zainaldeen NASSAR	827	Zsolt KESERŰ.....	1292
Žaklina KARAKLAJIĆ-STAJIĆ.....	212, 353, 371	Zvonko ZEKO	124
Žarko ILIN	494, 507		