

## Table of contents

Opening address by Jan Nedělník, Agricultural Research, Ltd., Troubsko . . . . .	1
Preface . . . . .	3
Miroslav Trnka, Jan Balek, Mikhail A. Semenov, Daniela Semerádová, Jørgen E. Olesen, Josef Eitzinger, Andreas Schaumberger, Pavel Zahradníček, David Kopecký Future agroclimatic conditions and implications for European grasslands. . . . .	5
Bohumír Cagaš Seed production of grasses and legumes in the Czech Republic and its impact on the agro and environmental sphere. . . . .	6
<b>Session I: Genetic resources and natural diversity</b>	
Phillip G.H. Nichols Use of genetic resources and natural diversity in forage breeding: a case study of annual legumes in Australia . . . . .	8
Michelle M. Nay, Christoph Grieder, Lea A. Frey, Helga Amdahl, Jasmina Radovic, Libor Jaluvka, Anna Palmé, Leif Skøt, Tom Ruttink, Roland Kölliker Home sweet home – the genetic and phenotypic adaptation of red clover to European growing environments . . . . .	11
Marie Pégard, Matthew C Fitzpatrick, Jean-Paul Sempoux Assessment of vulnerability to climate change in natural populations of perennial ryegrass across Europe from allele frequencies at adaptive loci. . . . .	14
Odd Arne Rognli, Trygve Sveen Aamlid, Muath Alsheik, Helga Amdahl, Sigridur Dalmannsdottir, Kristoffer Herland Hellton, Marit Jørgensen, Mallikarjuna Rao Kovi, Therese Mæland, Akhil Reddy Pashapu, Ilevina Sturite, Thordis Linda Thorarinsdottir, Susanne Windju Securing adaptation of timothy cultivars under climate change and during seed multiplication . . . . .	15
Beat Boller, David Kopecký Triploid hybrids <i>Festuca apennina</i> × <i>Lolium</i> occur rarely in nature but show high colonizing potential without dominating the sward excessively . . . . .	17

<b>Bill Biligetu, Hu Wang</b> Genetic variation and genome-environment association of alfalfa ( <i>Medicago sativa</i> L.) populations originating from long-term grazing sites. . . . .	20
<b>Philip Greenspoon, Lorena Batista, Jon Bančič, Linda Öhlund, Alf Ceplitis, Gregor Gorjanc</b> Genetic gain from simulated forage breeding programs with genomic selection. . . . .	21
<b>Mareike Kavka, Michael Melzer, Klaus J. Dehmer, Evelin Willner</b> Shattering resistance in genetic resources of the fodder grasses <i>Lolium perenne</i> L. and <i>Festuca pratensis</i> Huds. . . . .	22
<b>Monica Alexandrina Tod, Mironela Bălan</b> Allelopathic effect of herbage water extracts on seed germination and seedling development of some perennial grassland species . . . . .	24
<b>Ana Uhlarik, Marina Čeran, Đorđe Krstić, Zlatica Mamlić, Snežana Katanski, Sanja Vasiljević, Anja Dolapčev Rakić</b> Agronomical traits, seed color and protein content of protein pea ( <i>Pisum sativum</i> L.) cultivars grown in European conditions . . . . .	25
<b>Sanja Vasiljević, Mira Mikulić, Jelena Cvejić, Zorica Nikolić, Snežana Katanski, Zlatica Mamlić, Ana Uhlarik</b> Isoflavones profiles of some diploid and tetraploid red clover cultivars ( <i>Trifolium pratense</i> L.) at flowering stage. . . . .	27
<b>Tomáš Vymyslický, Simona Raab, Ivana Frei, Helena HutYROVÁ</b> Grass and forage legume genetic resources in the Czech Republic and their practical utilization . . . . .	28
<b>Yutang Chen, Roland Kölliker, Dario Copetti, Bruno Studer</b> Assembling forage grass genomes in the long-read sequencing era: a case study with <i>Lolium perenne</i> L. and <i>L. multiflorum</i> Lam. . . . .	31
<b>Mirjana Petrović, Vladimir Zornić, Zoran Lugić, Marija Stepić, Mladen Prijović, Tomaš Vymyslicky, Boban Andjelković</b> An initial metabolomic study on Hungarian clover . . . . .	33
<b>Bertrand Annick, Claessens Annie, Baron Vern, Thériault Mireille, Rocher Solen, Asselin Sean</b> Evaluation of alfalfa populations selected for reduced fall dormancy in a frequent cutting trial . . . . .	35

**Josef Haki, Aldo Tava, Zdeňka Kozová**  
 Variability of sapogenins among *Medicago falcata* entries . . . . . 37

**Mallikarjuna Rao Kovi, Odd Arne Rognli**  
 Genome assembly and annotation of timothy (*Phleum pratense* L.) . . . . . 40

**Snežana Babić, Jasmina Radović, Snežana Andjelković, Mirjana Petrović,  
 Goran Jevtić, Mladen Prijović, Dejan Sokolović**  
 Heritability and variability of the most important traits of meadow fescue  
 synthetic cultivars . . . . . 41

## Session II:

### Advanced phenotyping and genotyping technologies

**Bernadette Julier, Philippe Barre, Marie Pégard**  
 New phenotyping, genotyping and statistical tools for forage breeding . . . . . 44

**Jenny Kiesbauer, Christoph Grieder, Meril Sindelar, Linda Helene Schlatter,  
 Maria Hug, Daniel Ariza Suarez, Dario Copetti, Bruno Studer, Roland Kölliker**  
 A nested association mapping population reveals candidate genes for  
 stem rust resistance in Italian ryegrass . . . . . 47

**Oldřich Trněný, Jana Staveníková, Magdalena Dybová, Hana Jakešová,  
 Tereza Vojtková, Kateřina Holušová, Jan Šafář, Jan Nedělník**  
 Red clover's genetic playground: Leveraging low-coverage resequencing for  
 enhanced breeding programs . . . . . 49

**Stephen Byrne, Krishna Arojju Sai, Patrick Conaghan, Agnieszka Konkolewska,  
 Dan Milbourne**  
 Implementation of multiple cycles of genome-wide selection for  
 seasonal forage yield in perennial ryegrass. . . . . 51

**Peter Lootens, Joanna Pranga, Waldo Deroo, Tom De Swaef, Guillaume Blanchy,  
 Tommy D'Hose, Bart Vleminckx, Sarah Garré, Isabel Roldán-Ruiz**  
 Phenotyping our future crops: in-field, non-destructive, high-throughput  
 phenotyping of above and belowground plant traits . . . . . 52

**Agnieszka Konkolewska, Steffie Phang, Patrick Conaghan, Dan Milbourne,  
 Susanne Barth, Rachel Keirse, Aonghus Lawlor, Stephen Byrne**  
 Use of NIR spectra to predict heading date in perennial ryegrass . . . . . 55

<b>Nagarjun Devabhakthini, Doerte Harpke, Mareike Kavka, Evelin Willner, Klaus J. Dehmer</b>	
Exploring the genetic diversity of the IPK <i>Medicago</i> germplasm collection using GBS. ....	57
<b>Luciano Pecetti, Nelson Nazzicari, Nicolò Franguelli, E. Charles Brummer, Paolo Annicchiarico</b>	
Development and proof-of-concept application of genome-enabled selection for alfalfa biomass yield in Northern Italy: preliminary results . . . . .	58
<b>Girma Bedada, Yousef Rahimi, Silvana Moreno, Linda Öhlund, Alf Ceplitis, Anne-Maj Gustafsson, Anna Westerbergh, Pär K Ingvarsson</b>	
Haplotype-phased genomes of timothy grasses – <i>P. nodosum</i> , <i>P. alpinum</i> <i>P. pratense</i> . . . . .	60
<b>Harkingto Harkingto, Sahameh Shafiee, Stefano Zanotto, Helga Amdahl, Luciano Pecetti, Nelson Nazzicari, Paolo Annicchiarico, Åshild Ergon</b>	
Conventional and UAV-based phenotyping to characterize a broad collection of European lucerne germplasm in a Nordic environment. . . . .	62
<b>Joanna Pranga, Irene Borra-Serrano, Tom De Swaef, Mathias Cougnon, An Ghesquiere, Jonas Aper, Ivan Janssens, Greet Ruyschaert, Isabel Roldán-Ruiz, Peter Lootens</b>	
Unleashing the potential of drones: how high-throughput field phenotyping can assist forage grass breeding . . . . .	64
<b>Kioumars Ghamkhar, Dongwen Lu, Kenji Irie, Michael Hagedorn, Mostafa Sharifi, Steve Gebbie, Angus Heslop, Anthony Hilditch, Will Clayton, Brian Maw, Brent Barrett</b>	
Rapid forage yield and growth rate measurement using a remote-controlled LIDAR sensor in perennial ryegrass field plots . . . . .	67
<b>Youth Session</b>	
<b>Chloé Manzanares, Marius Rohner, Steven Yates, Maurice Bosch, Daniela Kupper, Daniel Thorogood, Bruno Studer</b>	
Exploiting new discoveries on self-incompatibility for forage grass breeding . . .	70
<b>Agnieszka Konkolewska, Steffie Phang, Michael Dineen, Patrick Conaghan, Dan Milbourne, Susanne Barth, Rachel Keirse, Aonghus Lawlor, Stephen Byrne</b>	
Establishing multi-trait genomic selection for forage improvement. . . . .	72

Ágnes Áldott-Sipos, Eszter Csepregi-Heilmann, Tamás Spitkó, János Pintér, Csaba Szőke, Tamás Berzy, Anett Kovács, János Nagy, Csaba L. Marton Evaluation of silage and grain yield of different maize ( <i>Zea mays</i> L.) genotypes in ecological and conventional conditions . . . . .	74
Marlies K.R. Peeters, Isabelle Maryns, Leen Leus, Joost Baert, An Ghesquiere, Mathias Cougnon, Aurélie Tredé, Sabine van Glabeke, Tom Eeckhout, Katrijn Van Laere, Yves Van de Peer, Tom Ruttink Optimized tetraploidization strategies in tissue culture for <i>Lolium</i> and <i>Festuca</i> . .	76
Ferez Sustek-Sánchez, Anete Boroduške, Madara Balode-Sausiņa, Erki Eelmets, Sanda Astra Bērziņa, Olav Kasterpalu, Merike Sõmera, Nils Rostoks, Cecilia Sarmiento Optimized <i>Lolium perenne</i> L. protoplasts isolation and transformation for CRISPR-Cas9 downstream applications. . . . .	78
<b>Session III:</b>	
<b>Qualitative and quantitative traits</b>	
E. Charles Brummer Thirty years of alfalfa genetic markers. . . . .	82
Hilde Muylle, Tim Vleugels, Reena Dubey, Aamir Saleem, Isabel Roldán-Ruiz GWAS for drought tolerance in red clover ( <i>Trifolium pratense</i> L.) . . . . .	84
Heathcliffe Riday, Neal Tilhou, Lisa Kissing Kucek, Shahjahan Ali, Brandon Carr, Annie Young-Mathews, Joel Douglas, Suresh Bhamidimarri, Mark Azevedo, Sarah Krogman, Maria Monteros, Steven B. Mirsky, Ryan Hayes, John Englert Breeding Soft-seeded Hairy Vetch . . . . .	86
Stanislav Hejduk, Ivana Koláčková, Barbora Smolková Differences between di- and tetraploid red clover cultivars. A review. . . . .	88
Jenny Kiesbauer, Maria Hug, Meril Sindelar, Linda Helene Schlatter, Jonathan Ohnmacht, Roland Kölliker, Christoph Grieder Higher seed yield through targeted selection for reduced seed shattering in Italian ryegrass ( <i>Lolium multiflorum</i> Lam.) . . . . .	89
Annie Claessens, Mireille Thériault, Annick Bertrand, Julie Lajeunesse, Solen Rocher Genetic selection for nonfiber carbohydrates in alfalfa ( <i>Medicago sativa</i> L.) stem . . . . .	91

**Session IV:  
Biotic and abiotic stresses**

- Susanne Barth, Lena Foerster, Linda Moloney-Finn, Carl Ng, Sheila Alves  
Differential growth of a panel of perennial ryegrass accessions  
following excess water treatment over the winter under field conditions . . . . . 94
- Tim Vleugels, Aamir Saleem, Reena Dubey, Hilde Muyllé, Irene Borra-Serrano,  
Peter Lootens, Tom De Swaef, Isabel Roldán-Ruiz  
Phenotypic characterisation of drought tolerance in red clover  
(*Trifolium pratense* L.) . . . . . 95
- Eszter Csepregi-Heilmann, Ágnes Áldott-Sipos, Anett Kovács, Tamás Spitkó,  
Csaba Szőke, János Pintér, Tamás Berzy, Adrienn Széles, Csaba L. Marton  
Cold stress study during emergence of maize (*Zea mays* L.) inbred lines . . . . . 98
- Mladen Prijović, Dejan Sokolović, Snežana Babić, Mirjana Petrović,  
Marija Stepić, Đorđe Lazarević, Aneta Sabovljević  
Morpho-biochemical response perennial ryegrass (*Lolium perenne* L.)  
populations to water shortage . . . . . 99
- Gražina Statkevičiūtė, Kristina Jaškūnė, Cecilia Sarmiento, Odd Arne Rognli,  
Nils Rostoks  
Fv:Fm and RWC measurements as indicators of drought stress response in  
perennial ryegrass . . . . . 101
- Miguel Loera-Sánchez, Damian Käch, Bruno Studer, Roland Kölliker  
Towards an efficient detection of genetic diversity in multispecies grassland . . 103
- Akhil Reddy Pashapu, Sigridur Dalmannsdottir, Marit Jørgensen,  
Marian Schubert, Odd Arne Rognli, Mallikarjuna Rao Kovi  
Surviving under ice: Insights into gene expression changes during  
ice-encasement in perennial grasses . . . . . 104
- Filip Bekčić, Marija Stepić, Snežana Anđelković, Jordan Marković,  
Nina Vučković, Ivana Vico, Nataša Duduk  
Wilt of red clover caused by *Fusarium oxysporum* . . . . . 105
- Bernadette Julier, Zineb El Ghazzal, Sabrina Delaunay, Béatrice Wolff,  
Gaëtan Louarn  
Early morphological traits condition the performance of lucerne plants in  
different competitive situations . . . . . 107

- Charlotte Jones, Matthew Lowe, Rhys Kelly, Denholm Bramble, Leif Skøt, David Lloyd**  
 Recurrent molecular selection for improved field resistance to crown rot (*Sclerotinia trifoliorum*) in red clover (*Trifolium pratense*) . . . . . 109
- Matthew Carl Graham, Lesley Suzanne Johnston, Alan Gordon, Gillian Kathleen Young**  
 Evaluating root characteristics under field conditions in perennial ryegrass for potential application in commercial breeding programmes . . . . . 110
- Shridhar Jambagi, Linda Öhlund, Christina Dixelius**  
 Red clover root microbiota and interaction of root rot and clover rot pathogens . . . . . 113
- Reah Gonzales, Steven Yates, Stéphane Charrier, Bruno Studer**  
 Divergent responses of perennial ryegrass and tall fescue to drought stress. . . 114
- Silvana Moreno-Vallejo, Girma Bedada, Yousef Rahimi, Pär Ingvarsson, Anna Westerbergh**  
 Response to waterlogging and drought in wild and domesticated accessions of timothy (*Phleum pratense*) and its wild relatives *P. alpinum* and *P. nodosum* . . 115

### ***Festulolium*** **Working Group Workshop**

- Vladimír Černoč**  
 History of *Festulolium* breeding in Czech Republic and future prospects . . . . . 118
- Tom Ruttink, Marlies Peeters, Isabelle Maryns, Leen Leus, Joost Baert, An Ghesquiere, Mathias Cougnon, Aurélie Tredé, Sabine van Glabeke, Tom Eeckhaut, Katrijn Van Laere, Yves Van de Peer**  
 Genome dominance in interspecific and intergeneric hybrids of *Lolium*, *Festuca* and *Festulolium*. . . . . 121
- Joanna Majka, Marek Glombik, Alžběta Doležalová, Jana Kneřová, Marco Tulio Mendes Ferreira, Zbigniew Zwierzykowski, Martin Duchoslav, Bruno Studer, Jaroslav Doležel, Jan Bartoš, David Kopecký**  
 Deciphering genome dominance in *Festulolium* . . . . . 124
- Philippe Barre, Sebastian Blugeon, Sabrina Delaunay, Lydia Jaffrelo, Brenadette Julier, Marie Pegard, Charles Poncet, Marc Ghesquière**  
 New insights of interspecific genetic variability within and between 4x *Festulolium* hybrid cvs by using KasPar markers. . . . . 126

<b>Vilma Kemešytė, Gražina Statkevičiūtė, Kristina Jaškūnė</b> Development and characterization of productive and resilient <i>Festulolium</i> hybrids for future climate .....	129
<b>Dawid Perlikowski, Adrianna Czapiewska, Izabela Pawłowicz,</b> <b>Włodzimierz Zwierzykowski, Eugeniusz Paszkowski, Katarzyna Szwarc,</b> <b>Katarzyna Kłodawska-Pęcińska, Dariusz Rydzyński, Łukasz Wańkiewicz,</b> <b>Marcin Rapacz, Arkadiusz Kosmala</b> Physiological and molecular indicators of winter-hardiness and frost tolerance in <i>Lolium perenne</i> × <i>Festuca pratensis</i> hybrids .....	131
List of participants .....	133

### Programme

EUCARPIA Brno 2023 conference – Preliminary programme “Novel technologies, strategies and crops to sustain forage production in future climate” .....	140
---	-----