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IBRA

4th European Buckwheat Symposium - Buckwheat: Innovations in Agriculture, Breeding, Nutrition and Sustainability

ABSTRACT BOOK

September 3rd - 5th, 2025
Nyíregyháza, Hungary

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Abstract Book of the 4th European Buckwheat Symposium - Buckwheat: Innovations in Agriculture, Breeding, Nutrition and Sustainability; September 3rd - 5th, 2025, Nyíregyháza, Hungary

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Program

September 03, 2025		
08:00 - 09:00	Registration	
09:00 - 10:10	Welcome Address	
Session 1	Chairpersons: Gabriela Renée Alandia, Nóra Mendler-Drienyovszki	Genetic and breeding/ Genetic resources, germplasm collection
10:10-10:30	Taiji Adachi (Japan)	For the further Progress to buckwheat renaissance, world wide - Present Status and Prospects for breakthrough to improving qualitative and quantitative productivity of Buckwheat by means of Plant Biotechnology
10:30 – 10:50	Meiliang Zhou (China)	Genetic insights into distant hybridization between Tartary buckwheat and Golden buckwheat
10:50 – 11:10	Anika Wiese-Klinkenberg (Germany)	Pre-breeding for German climate-resilient multi-purpose buckwheat cultivars
11:10 – 13:00	Lunch	
Session 2 (Part 1)	Chairpersons: Meiliang Zhou, Katalin Magyar-Tábori	Physiology and responses to environmental conditions
13:00 – 13:20	Mateja Germ (Slovenia)	Content of mineral elements in common and Tartary buckwheat from different environments
13:20 – 13:40	Grazyna Podolska (Poland)	Buckwheat in the face of new challenges in agriculture
13:40 – 14:00	Hanász Alexandra (Hungary)	Effect of osmotic stress on buckwheat germination
14:00 – 14:20	Rakib Hossian Raihan (Poland)	Advanced remote sensing for assessing silicon-induced drought resilience in buckwheat
14:20 – 14:40	Coffee break	Conference Photo
Session 2 (Part 2)	Chairpersons Krysztof Dziedzic, Alexandra Hanász	Physiology and responses to environmental conditions
14:40 – 15:00	Milan Skalicky (Czech Republic)	Effect of foliar application of silicon (Si) on physiological and biochemical parameters of common buckwheat under drought conditions
15:00 – 15:20	Anshu Rastogi (Poland)	Advancing the European Green Deal with Remote Sensing: SCOPE Model Predictions of Buckwheat Yield Under Varied Water and Silicon Regimes
15:20 – 15:40	M. A. Mannan (Bangladesh) ONLINE	Interactive effects of rice husk biochar and zinc oxide nanoparticles on growth, physiology, and yield of buckwheat (*Fagopyrum esculentum*) under salinity stress
15:40 – 16:30	Grazyna Podolska (Poland), Jacek Kwiatkowski (Poland), Krysztof Dziedzic (Poland)	IBRA Discussion
18:00 – 21:30	Scientific Excursion and Dinner	Tarcal

September 04, 2025		
Session 3	Chairpersons: Mateja Germ, Nóra Mendler-Drienyovszki	Cultivation technology and its development
09:00 – 09:20	Jacek Kwiatkowski (Poland) (Plenary)	The effect of silicon on plant growth and development, yield and seed reproductive quality of *Fagopyrum tataricum* (L.) Gaertn.
09:20 – 09:40	Juhász Csaba (Hungary)	Assessment of phytotoxic effects of pre- and post-emergence herbicides on buckwheat (*Fagopyrum esculentum* Moench.) to identify selective weed control options
09:40 – 10:00	Nwajei Sunday Ebonka (Czech Republic)	The growth and biomass yield of common buckwheat *Fagopyrum esculentum* (L.) Moench. under different crop management systems
10:00 – 10:20	Pál Vivien (Hungary)	Evaluating the role of buckwheat in crop rotations under variable nutrient supply and climatic conditions
10:20 – 10:40	Matteo Ruggeri (Italy)	Preliminary results of a carbon farming cropping system in Hungary, and evaluation of the benefits of integrating buckwheat into crop rotation
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Session 5	Chairpersons: Grazyna Podolska, Vivien Pál	Nutritional values of buckwheat and food production and other processing technology
13:30 – 13:50	Ivan Kreft (Slovenia) (Plenary)	Nutritional value of buckwheat
13:50 – 14:10	Krysztof Dziedzic (Poland)	Dietary fiber content in husk from selected common buckwheat cultivars grown under varying irrigation systems
14:10 – 14:30	Zlata Luthar (Slovenia)	Condensed tannins in common and Tartary buckwheat seeds
14:30 – 14:50	Akanksha Dalal (India) ONLINE	Innovating Indian Chapaty with germinated buckwheat flour for glycemic control
14:50 – 15:00	Closing of the Symposium	
15:00 – 15:30	Coffee break	
19:00 – 23:00	Gala Dinner	Hunguest Hotel Sóstó
September 05, 2025		
09:00 – 11:30	Nóra Mendler-Drienyovszki, Marianna Makádi, László Zsombik	Introduction of the activities of the Nyíregyháza Research Institute and field demonstration
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SESSION 1

Genetic and Breeding, Genetic Resources, Germplasm Collection

Chairpersons:

Gabriela Renée Alandia and Nóra Mendler-Drienyovszki

Taiji Adachi: For the Further Progress to BUCKWHEAT-RENAISSANCE, Worldwide Present Status and Prospects for Breakthrough to Improving Qualitative and Quantitative Productivity of Buckwheat by Means of Plant Biotechnology

Meiliang Zhou: Genetic Insights into Distant Hybridization between Tartary Buckwheat and Golden Buckwheat

Anika Wiese-Klinkenberg, Linnéa Lukas, Kerstin A. Nagel, Beverley M. Wolters and Laura V. Junker Frohn: Pre-Breeding for German Climate-Resilient Multi-Purpose Buckwheat Cultivars

For the Further Progress to BUCKWHEAT-RENAISSANCE, Worldwide Present Status and Prospects for Breakthrough to Improving Qualitative and Quantitative Productivity of Buckwheat by Means of Plant Biotechnology

Taiji Adachi[1*]

[1*]Principal / Director; NPO Colloquia Naturae in Miyazaki, Japan

Keywords: Common buckwheat, *Fagopyrum esculentum*, Fertility, Floral biology

Looking back at the literature/history in east and west briefly, Buckwheat has been recognized as one of the old natural resources for mankind. This review mainly covers the recent development and potentiality of common buckwheat. 1) Biotechnology, it made us to understand Mendelian multiple allelic genes by induced auto tetraploid. 2) By-products were registered as much productive in tetraploid as the first new variety. 3) By using Homomorphic cross-compatible plant, we have succeeded to make a positional cloning of reproductive system in the common buckwheat, which made us much understanding to know how to overcome breeding barriers. It is, however, still trying to introduce the Apomictic gene from foreign species, without much success. 4) The other strategy has tried to make remote hybridization between self-compatible wild species, *F. homotropicum* and the common buckwheat by means of old and/or biotechnology. It is also still our scientific dream at the moment. 5) Determinant and non-determinant inflorescence change should be also challenged to harvesting in near future.
In conclusion, so many morphological traits, for example, root system improvement and semi- dwarfism against lodging are still a challenge remained for young scientists.

Genetic Insights into Distant Hybridization between Tartary Buckwheat and Golden Buckwheat

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Keywords: Bioactive substances, *Eriogonum flavum Nutt.*, *Fagopyrum tataricum*, Multi-Omics analysis, Rutin

Buckwheat, belongs to the Polygonaceae and the *Fagopyrum* genus, is an ancient crop traditionally used as a staple food in high-altitude areas. It accumulates abundant bioactive substances, especially flavonoid rutin, making it a dual-purpose crop with excellent nutritional quality and economic and ecological value, and popular around the world. At present, there are two most widely cultivated buckwheat species. Among them, Tartary buckwheat exhibited higher rutin content than common buckwheat. However, the rutin content in main cultivated Tartary buckwheat varieties is relatively low. And the insufficient research and utilization of germplasm resources seriously restrict genetic improvement of Tartary buckwheat with high rutin content. Population genetics revealed Himalayan origin and northern China dispersed to Europe of Tartary buckwheat. Multi-omics analysis revealed the genetic basis of decreased flavonoids along with yield increase during Tartary buckwheat domestication and identified key genes responsible for yield and rutin content regulation. As the wild-relative of Tartary buckwheat, golden buckwheat exhibits high content of rutin, making it an ideal material for high rutin buckwheat breeding. We thus evaluated the agronomic traits and rutin content in golden buckwheat germplasm resources, and identified germplasms with excellent agronomic traits and rutin content, as well as good compatibility with Tartary buckwheat. We further utilize these excellent golden buckwheat germplasms for distant hybridization with the main cultivated varieties of Tartary buckwheat. The agronomic traits and rutin content of hybrid offspring are higher than those of cultivated Tartary buckwheat. The successful application of this wild-relative resource improved cultivated variety provides a theoretical and practical foundation for future research on crop breeding and improvement.

Pre-Breeding for German Climate-Resilient Multi-Purpose Buckwheat Cultivars

Anika Wiese-Klinkenberg[1,3*], Linnéa Lukas[1,3], Kerstin A. Nagel[2,3], Beverley M. Wolters[2,3] and Laura V. Junker Frohn[2,3]

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Keywords: Drought, Image-based phenotyping, Multi-purpose, Root, Rutin

Buckwheat production in Germany is lagging behind the increasing interest in buckwheat products. The interdisciplinary project BIMOTEC aims to strengthen buckwheat breeding and production in Germany by unravelling its potential as multi-purpose crop to leverage buckwheat grains for food production, stems for extraction and valorization of lignocellulose and residual leaf biomass for the extraction of biobased compounds. Buckwheat grains and leaves contain large quantities of industrially valuable secondary metabolites. These phytochemicals have various health beneficial properties and can be used in the food and pharmaceutical industries. By investigating the potential of buckwheat for the extraction of valuable phytochemicals from leaves and hulls as well as lignocellulose from stems, BIMOTEC contributes to establish innovative bio-based value chains. Application of phenotyping, transcriptomics and metabolomics for pre-breeding analysis of relevant traits in greenhouse and field experiments and development of modern breeding technologies offer great potential to bring forward breeding of climate-resistant German buckwheat varieties. We will establish new phenotyping technologies for buckwheat to support buckwheat breeding. Image-based phenotyping of 60 buckwheat accessions will be used to assess genotypic variation in drought stress tolerance and to further investigate the underlying mechanisms by gene expression analysis. Using the novel automated phenotyping platform GrowScreen-Rhizo III, we will focus on the so far under-investigated growth and architecture of many buckwheat accessions, also in response to drought and nutrient deficiency. In addition, the genotypic variation in the content of the valuable flavonoid rutin in leaves will be quantified. We will show first results of the establishment of buckwheat phenotyping of shoot and root growth dynamics for the identification of robust accessions as contribution to pre-breeding of future climate resilient cultivars.

SESSION 2

Physiology and Responses to Environmental Conditions

Chairpersons:

Meiliang Zhou and Katalin Magyar-Tábori;
Krysztof Dziedzic and Alexandra Hanász

Mateja Germ, Ivan Kreft, Katarina Vogel Mikuš, Jure Mravlje, Paula Pongrac, Matevž Likar, Anja Mavrič Čermelj, Aleksandra Golob and Marjana Regvar: Content of Mineral Elements in Common and Tartary Buckwheat from Different Environments

Grażyna Podolska: Buckwheat in the Face of New Challenges in Agriculture

Alexandra Hanász: Effect of osmotic stress on buckwheat germination

Rakib Hossian Raihan, Michal Antala, Mar Albert Saiz, Abdallah Yussuf Ali Abdelmajeed, Marcin Stróżecki, Radosław Juszczak and Anshu Rastogi: Advanced remote sensing for assessing silicon-induced drought resilience in buckwheat

Jiri Krucky, Vaclav Hejnak, Pavla Vachova, Aayushi Gupta, Jitka Skalicka and Milan Skalicky: Effect of foliar application of silicon (Si) on physiological and biochemical parameters of common buckwheat under drought conditions

Alain Bertin Abayo, Michal Antala, Mar Albert-Saiz, Marcin Strozecki, Radosław Juszczak and Anshu Rastogi: Advancing the European Green Deal with Remote Sensing: SCOPE Model Predictions of Buckwheat Yield Under Varied Water and Silicon Regimes

M. A. Mannan, Masuma Akter, M. T. Akter and J. K. Sah: Interactive effects of rice husk biochar and zinc oxide nanoparticles on growth, physiology, and yield of buckwheat (*Fagopyrum esculentum*) under salinity stress

Content of Mineral Elements in Common and Tartary Buckwheat from Different Environments

Mateja Germ[1*], Ivan Kreft[1], Katarina Vogel Mikuš[1,2], Jure Mravlje[1,2], Paula Pongrac[1,2], Matevž Likar[1], Anja Mavrič Čermelj[1], Aleksandra Golob[1] and Marjana Regvar[1]

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Keywords: Elemental composition, Elevation, Grain, Leaves, Mycorrhiza

Common buckwheat and Tartary buckwheat, grown at three locations with different elevations: 300 m (Ljubljana), 600 m (Podbeže) and 1200 m (Javorje) above sea level (Slovenia), were studied for the concentration of mineral elements, primary and secondary metabolites, and mycorrhizal colonization. Locations differed in macro and microclimatic conditions as well as in soil properties. Microscopic examination of roots revealed the presence of mycorrhizal fungi in both buckwheat species. The frequency (F%) and intensity (M%) of fungal root colonisation showed no significant differences between common buckwheat and Tartary buckwheat, however significant differences were observed across different locations. Roots of both buckwheat species from Podbeže had higher F% and M%. Plants grown in location Podbeže had the highest concentration of phosphorus (P) and potassium (K) in their leaves compared to plants from Ljubljana and Javorje, however there were no significant differences in the elemental composition of buckwheat grains from different locations. Better P and K status of buckwheat leaves from Podbeže could be a consequence of soil properties and greater mycorrhizal colonization of roots observed in buckwheat from Podbeže. The elemental composition of leaves and grains was similar in both species, except common buckwheat had a higher concentration of sulphur (S) in leaves than Tartary buckwheat, regardless of the growth location. The higher concentration of S in leaves of common buckwheat could be a consequence of the higher content of S-containing amino acids or the higher content of proteins in general in common buckwheat (Sytar et al., 2018). Leaves of Tartary buckwheat had a significantly higher concentration of rutin than common buckwheat, indicating greater investment in secondary metabolites and protection against environmental constraints. Buckwheat species grown at the highest elevation had the highest concentration of rutin, which absorbs radiation and preserves vulnerable structures and processes in plant tissue.

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Buckwheat in the Face of New Challenges in Agriculture

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Keywords: Climate change, Environmental degradation, Food quality

Modern agriculture faces numerous challenges resulting from climate change, environmental degradation, progressive urbanization, and growing societal expectations regarding food quality. These issues necessitate the search for new strategies and solutions that combine production efficiency with the principles of sustainable development. Increasing attention is being given to crops that can serve as alternatives to intensive cereal monocultures, including buckwheat (*Fagopyrum esculentum* Moench), classified as a pseudocereal.

Buckwheat presents an interesting alternative within the modern agricultural model. Its numerous advantages align well with the needs of sustainable agricultural production:

1. **Low soil and fertilization requirements** – Buckwheat can grow in poor soils and does not require intensive fertilization, which reduces chemical pressure on the environment (Borkowska, 2018).
2. **Climatic flexibility** – A short vegetation period and tolerance to water stress make it resilient to changing weather conditions.
3. **Supporting biodiversity** – As a melliferous plant, it contributes to pollinator protection and enriches agroecosystems.
4. **Natural disease resistance** – Reduced need for chemical plant protection lowers environmental contamination and decreases production costs.
5. **Use of buckwheat in functional food productio**n – Buckwheat is characterized by high nutritional value and a rich profile of bioactive compounds that determine its health-promoting effects. Particularly important are flavonoids (e.g., rutin), lignans, phenolic acids, as well as easily digestible proteins and dietary fiber.

The cultivation of buckwheat may be an effective response to contemporary agricultural challenges. Its ecological, agronomic, and nutritional benefits make it a valuable crop to promote, particularly in the context of organic, local, and health-focused agriculture. In an era that demands the restructuring of the food system, buckwheat deserves greater attention from both producers and consumers.

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Effect of Osmotic Stress on Buckwheat Germination

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Keywords: Environmental adaptation, Osmotic stress tolerance, Poliethylene glycol (PEG)

Buckwheat (*Fagopyrum esculentum* Möench) is an annual plant that, while classified as a pseudocereal, is often grouped with cereals due to its chemical composition and uses. In terms of its nutritional benefits, it is capable of treating or preventing various diseases, such as diabetes, hypertension, and certain cancers (Campbell, 1997).

Buckwheat is primarily cultivated in China and the Russian Federation, with areas of 1.03 and 0.62 million hectares in 2023, respectively (FAO, 2025). Between 1991 and 2017, the buckwheat cultivation area in Hungary fluctuated between 224 and 1857 hectares, while the yield also varied significantly, ranging from 0.35 to 1.5 tons per hectare (FAO, 2025). Although buckwheat is cultivated on a small area in Hungary, its significance is growing, particularly in light of the 2017 regulation, which expanded the composition of bakery products to include pseudocereals like buckwheat (Hungarian Food Codex, 2017).

The changing climate has made buckwheat cultivation more difficult in Hungary. The two varieties, 'Hajnalka' and 'Oberon' on the official cultivar list were unable to adapt quickly to the changing climatic conditions. As a result, fluctuations in yields and a decline in cultivated areas have been observed. To improve the effectiveness of breeding work, it is especially important to test the stress tolerance of genotypes, which could help identify varieties better suited to dry conditions, temperature extremes, and the increasingly unpredictable weather patterns. This approach could contribute to making buckwheat cultivation more sustainable and successful in the future, particularly in light of the 2017 regulation, which promoted the use of pseudocereals, including buckwheat, in bakery products.

To meet the growing societal demand, it is important to support the increase in buckwheat cultivation volume by breeding varieties that can adapt to various environmental conditions, and by providing stable performance, contribute to maintaining food supply. Experiments aimed at osmotic stress tolerance may reveal close correlations with the plant's drought tolerance capacity. Recent articles provide a more accurate picture of the effects of osmotic stress applied during early developmental stages, such as germination, and the published information serves as valuable guidance for fine-tuning breeding work.

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Advanced Remote Sensing for Assessing Silicon-Induced Drought Resilience in Buckwheat

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Keywords: Hyperspectral remote sensing, Phenotyping, Spectral vegetation indices, Sun-induced fluorescence

Climate change has significantly increased the vulnerability and challenges associated with crop cultivation, largely due to the onset of various abiotic stress factors, particularly drought. Recent advancements in hyperspectral technologies now enable rapid, real-time phenotyping. Among the various optical remote sensing signals, sun-induced fluorescence (SIF) has emerged as one of the most promising tools for detecting the effects of drought stress on plants. The present study aimed to identify the efficient use of advanced remote sensing for phenotyping silicon-induced physiological responses in three buckwheat genotypes subjected to drought stress. Hyperspectral irradiance and radiance data were collected using the Piccolo Doppio system from well-irrigated and non-irrigated field plots, both with and without silicon treatment. Several vegetation indices were computed from the spectral data, including the normalized difference vegetation index (NDVI), near-infrared reflectance of vegetation (NIRv), renormalized difference vegetation index (RDVI), normalized photochemical reflectance index (PRI_{norm}), optimized soil adjusted vegetation index (OSAVI), Vogelmann 2 index (Vog2), MERRIS terrestrial chlorophyll index (MTCI), carotenoid reflectance index (CAR), and anthocyanin reflectance index (ANTH). Our findings revealed that drought stress induced a notable reduction in NDVI, NIRv, RDVI, OSAVI, CAR, and ANTH across all genotypes. In contrast, PRI_{norm}, Vog2, and ANTH exhibited an increase under drought conditions. Moreover, SIF integrated over 670 to 780 nm also showed a reduction in fluorescence intensity in all genotypes under drought stress. Notably, plants that subsequently received water demonstrated a faster recovery, as reflected in the improvements in SIF and vegetation indices. Therefore, the results of the current study indicated the potential of hyperspectral vegetation indices and SIF measurements as reliable, non-invasive tools for monitoring drought stress in buckwheat. Such approaches can significantly aid precision agriculture and targeted breeding programs aimed at enhancing stress resilience.

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Effect of Foliar Application of silicon (Si) on Physiological and Biochemical Parameters of Common Buckwheat under Drought conditions

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Keywords: 5-methylcytosine, malondialdehyde, photosynthetic pigments, total antioxidant capacity, water stress

The experiment aimed to determine how foliar application of silicon affects physiological and biochemical parameters in selected buckwheat genotypes grown under regular water regime and water stress. Young plants of three genotypes of buckwheat (La Harpe, Panda and Smuga) were grown under controlled conditions in a growth chamber in peat containers on four treatments: Control (80% of the substrate water capacity), Drought (40% of the substrate water capacity), Control + Si (0.5 mM), Drought + Si (0.5 mM).
Drought stress was reflected in all genotypes by statistically significant decreases in relative water content (RWC) as an indicator of plant hydration, leaf osmotic potential (Ψ_s) as an indicator of osmotic regulation, and increases in malondialdehyde content (MDA) as an indicator of increased ROS production, increased antioxidant production, i.e., by increasing total flavonoid content (TFC) and total antioxidant capacity (TAC). By increasing the level of 5-methylcytosine (5mC) as a regulator of gene transcription in the plant response to stress conditions, statistically significant decreases in photosynthetically active pigments (Chl *a*, Chl *b*, total chlorophyll and carotenoids), leaf gas exchange parameters - net photosynthetic rate (*A*), transpiration rate (*E*) and stomatal conductance (g_s), but no decrease in the function or damage of PSII reaction centres expressed as Fv/Fm ratio. At the same time, however, significant genotypic differences were found in response to drought and foliar application of Si. La Harpe and Panda genotypes showed statistically significantly lower RWC Ψ_s, *A*, *E*, and g_s under water stress than the Smuga genotype. Under drought stress, La Harpe showed the highest MDA value in roots, statistically significantly higher 5mC content in leaves than the other genotypes, and only it showed a statistically significant decrease in WUE. The Smuga genotype showed the highest natural proline level and increased leaves under water stress.
Foliar application of Si positively affected cell membrane stability and increased antioxidant activity in all buckwheat genotypes. This was reflected in decreased MDA content and increased TFC and TAC in roots and leaves of control and stressed plants. La Harpe showed the most significant response to Si application regarding increased TFC and TAC. In all genotypes, there was a beneficial effect of Si application to the leaf on the protection of photosynthetic pigments from oxidative damage under water stress, which was reflected by an increase in the content of Chl *a*, Chl *b*, total chlorophyll and carotenoids. At the same time, significant genotypic differences were found in response to foliar application of Si. In La Harpe and Panda, drought stress following Si application resulted in statistically significant increases in RWC, Ψ_s and leaf gas exchange parameters (*A*, *E*, g_s). In the Smuga genotype, the effect of Si on these characteristics was inconclusive.

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Advancing the European Green Deal with Remote Sensing: SCOPE Model Predictions of Buckwheat Yield under Varied Water and Silicon Regimes

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Keywords: Drought tolerance, *Fagopyrum*, morphological traits, physiological characteristics, precision agriculture

To support sustainable agriculture under climate change—a key objective of the European Green Deal (EGD)—this study uses remote sensing and radiative transfer modeling to optimize crop productivity under water-limited conditions. We employed the Soil Canopy Observation, Photosynthesis, and Energy Fluxes (SCOPE) model to predict the yield of three buckwheat genotypes (La Harpe, Smuga, Panda) under four treatments: irrigated/non-irrigated regimes with and without silicon supplementation. The model was first inverted to retrieve plant traits (Leaf Area Index, LAI; chlorophyll content, Cab) from canopy spectra, then run in forward mode to simulate daily Gross Primary Production (GPP). Field-measured LAI correlated strongly with SCOPE predictions (R^2 = 0.84, RMSE = 0.33), though chlorophyll estimation was affected by sampling bias. Yield was derived by integrating daily GPP with genotype-specific harvest indices (HI: 0.13 for La Harpe and Panda, 0.09 for Smuga), showing promising agreement with harvested yields. Notably, silicon application enhanced drought resilience only in La Harpe, highlighting genotype-dependent responses. These findings demonstrate how remote sensing-driven models like SCOPE can guide precision agriculture, aligning with the EGD's goals of resource-efficient farming and climate adaptation.

Acknowledgment: This work was supported by the project funded by the National Science Centre of Poland (NCN), Project No. 2021/43/I/NZ9/01356.

Interactive Effects of Rice Husk Biochar and Zinc Oxide Nanoparticles on Growth, Physiology, and Yield of Buckwheat (*Fagopyrum esculentum*) under Salinity Stress

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Keywords: Antioxidant, Biochar, buckwheat, nanoparticle, salinity

Salinity stress affects negatively on physiological and biochemical processes of plants, leading to reduced yields. This study addresses the knowledge gap regarding effective strategies to mitigate salinity-induced damage and enhance productivity in buckwheat. We hypothesized that zinc oxide nanoparticles (ZnO NPs) and rice husk biochar could improve salinity tolerance in buckwheat by modulating its physiological and biochemical responses. To test this, buckwheat plants were grown under irrigation with well-watered (0 mM salinity) and moderate saline water (7.5 mM salinity) following a completely randomized design (CRD) with three replications. Results showed that the application of 50 g/kg rice husk biochar and 200 ppm ZnO NPs, either separately or in combination, significantly enhanced the yield and improved key physiological and biochemical traits, including relative water content, photosynthetic rate, stomatal conductance, chlorophyll content, and antioxidant activity. The combination of Fe3O4 NPs and rice husk biochar led to improvements the plants' relative water content, photosynthetic rate, chlorophyll levels, membrane stability index, proline, antioxidant activity (DPPH), and seed yield by 18.32, 15.29, 40.18, 14.54, 38.56, 6.87, and 40.78%, respectively compared to untreated salinity plants. Moreover, this treatment reduced oxidative stress indicators such as hydrogen peroxide and malondialdehyde by 25.56 and 35.0%, respectively. These results show that ZnO NPs, when combined with rice husk biochar, significantly improve salinity tolerance in common buckwheat, providing a viable strategy to increase crop yields in water-limited environments. In view of climate change, this study emphasizes the potential of combining biochar with nanomaterials for sustainable agricultural practices.

SESSION 3

Cultivation Technology and its Development

Chairpersons:

Mateja Germ and Nóra Mendler-Drienyovszki

Jacek Kwiatkowski (Plenary): The effect of silicon on plant growth and development, yield and seed reproductive quality of *Fagopyrum tataricum* (L.) Gaertn.

Csaba Juhász and László Zsombik: Assessment of phytotoxic effects of pre- and post-emergence herbicides on buckwheat (Fagopyrum esculentum Moench.) to identify selective weed control options

Nwajei Sunday Ebonka and Jana Pexová Kalinová: The Growth and Biomass Yield of Common Buckwheat (Fagopyrum esculentum (L.) Moench) Under Different Crop Management Systems

Vivien Pál and László Zsombik: Evaluating the role of buckwheat in crop rotations under variable nutrient supply and climatic conditions

Matteo Ruggeri and Andrea Anselmi: Preliminary results of a carbon farming cropping system in Hungary, and evaluation of the benefits of integrating buckwheat into crop rotation

The Effect of Silicon on Plant Growth and Development, Yield and Seed Reproductive Quality of *Fagopyrum tataricum* (L.) Gaertn.

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Keywords: Seeds quality, silicon, Tartary buckwheat, yield

Tartary buckwheat is the second most important species of the *Fagopyrum* genus (Kwiatkowski, 2010). It is characterized by a higher nutritional and nutraceutical value than common buckwheat (Manzoor et al, 2025). Tartary buckwheat is considered a species strongly adapted to growth in unfavorable conditions: drought, cold and high concentration of aluminum ions (Zhang et al., 2017). However, previous own studies have shown strong fluctuations in the yield of Tartary buckwheat in the years of the study (Kwiatkowski et al., 2019).

The study was conducted to assess the effect of silicon application on the growth, development, yield and seed reproduction quality of Tartary buckwheat cultivated in north-eastern Poland in 2022-2024. The experiment included 3 genotypes of Tartary buckwheat. The silicon biostimulator was applied in the form of 3 foliar sprays applied at 21-day intervals starting from the 3-leaf stage (BBCH 13), at a dose of 250 g ha-1 each. The use of silicon caused an increase in the air-dry mass of plants, an increase in the number of inflorescences and seeds from one plant, an increase in the bulk density of achenes and a shortening of the germination time of a single seed. The use of biostimulator had no effect on the yield of achenes and their germination. The main factors strongly differentiating the characteristics of plants and the yield of Tartary buckwheat were the weather conditions in the years of the study and the Tartary buckwheat genotypes used.

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Acknowledgment: This research results from a study carried out at the University of Warmia and Mazury in Olsztyn, Faculty of Agriculture and Forestry, Department of Genetics, Plant Breeding and Bioresource Engineering, topic number 30.610.007-110. Funded by the Minister of Science under the "Regional Initiative of Excellence Program".

Assessment of Phytotoxic Effects of Pre- and Post-Emergence Herbicides on Buckwheat (*Fagopyrum esculentum* Moench) to Identify Selective Weed Control Options

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Keywords: NDVI values, phytotoxicity, weed management

Weeds could be a challenge to buckwheat cultivation because the crop is susceptible to herbicides, which limits weed control options (Podolska et al., 2019). Field experiments comparing untreated controls with treated plots have shown that the spread of dicotyledonous weeds negatively affects buckwheat yield (Wall & Smith, 1999). Building on our 2023 trials, we conducted small plot field experiments in 2024 to evaluate various pre- and post-emergence herbicides on the buckwheat cultivar 'Hajnalka'. Pre-emergence treatments included flurochloridone 500 g ai ha^{-1} and S-metolachlor 1344 g ai ha^{-1}. In addition, 2,4-D (600 g ai ha^{-1}), clopyralid (120 g ai ha-1) halauxifen-methyl (2.5 and 3.1 g ai ha^{-1}), halauxifen-methyl + picloram (2.5 + 12 and 5 + 25 g ai ha^{-1}), halauxifen-methyl + clopyralid (3.8 + 90 and 5 + 120 g ai ha^{-1}), metribuzin (180 and 240 g ai ha^{-1}), sulfosulfuron (6 and 7.5 g ai ha^{-1}), thifensulfuron-methyl (7.5 g ai ha^{-1}), mesotrione (120 g ai ha^{-1}), and terbuthylazine + mesotrione + S-metolachlor (500 + 150 + 1500 g ai ha^{-1}) were applied post-emergence. We assessed treatments using NDVI measurements and visual phytotoxicity ratings, along with plant height, yield contamination, clean seed yield, and 1000 seed weight. Results indicated variability compared to 2023 findings. Despite no significant differences in NDVI, S-metolachlor treatment showed clear phytotoxicity symptoms. In terms of yield, the treated plants produced lower yields than the control, although the difference was not statistically significant. Clopyralid, mesotrione, halauxifen-methyl + clopyralid, and metribuzin treatments produced higher NDVI values than the controls. No phytotoxic symptoms appeared in clopyralid and mesotrione treated plants. Only the seed yield of the plants treated with metribuzin exceeded that of the control plants, although the difference was not statistically significant. The strongest negative correlation was observed between phytotoxicity and plant height. Further testing of the treatments that produced positive results is warranted in small plot field experiments.

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The Growth and Biomass Yield of Common Buckwheat (*Fagopyrum esculentum* (L.) Moench) Under Different Crop Management Systems

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Keywords: Biomass yield, Growth characteristics, Intercropping, Variety

Growing crops as cover or companion crops, as well as for green manure, forms the basis of sustainable and organic field crop production. This practice helps reduce soil degradation and supports sustainable soil management. The aim of this field study was to investigate the effects of different crop management systems on the growth and biomass yield of two varieties of common buckwheat. The following crop management systems were tested: Control (buckwheat grown alone), buckwheat intercropped with sorghum (*Sorghum bicolor*), buckwheat intercropped with a mixture of lacy phacelia (*Phacelia tanacetifolia*) and white mustard (*Sinapis alba*), buckwheat grown in postharvest wheat residues (straw). The experiment was laid out in a randomized complete block design with three replicates. Data were collected on vegetative parameters such as plant height, number of leaves per plant, number of branches per plant, leaf area per plant, stem thickness (in sorghum), and biomass yield. Two varieties of common buckwheat, Zoe and Harpe, were used. The results showed that the crop management system significantly affected the growth characteristics of buckwheat. Crop management systems had a statistically significant effect on the number of branches per plant, leaf area, stem thickness of buckwheat, and overall biomass yield. The highest biomass yield (5.52 t/ha fresh weight and 1.13 t/ha dry weight) was obtained from the Harpe variety intercropped with lacy phacelia and white mustard, while the least yield (2.75 t/ha fresh weight and 0.71 t/ha dry weight) was recorded in the control treatment. Given the high biomass yields, intercropping common buckwheat with lacy phacelia and white mustard is a promising option for green manure production. Although the buckwheat varieties differed in vegetative traits such as number of leaves, leaf area, and number of branches per plant, the variety used did not have a statistically significant effect on biomass yield.

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Evaluating the Role of Buckwheat in Crop Rotations under Variable Nutrient Supply and Climatic Conditions

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Keywords: crop rotation, organic matter, phosphorus content, regenerative practices, yield

Implementing regenerative practices that prioritize diverse plant species in crop rotations not only reduces the need for synthetic fertilizers but also lowers the overall carbon footprint of crop production. By incorporating different crops with complementary root structures and nutrient requirements, soil health is enhanced through improved organic matter content, enhanced nutrient cycling, and increased microbial diversity. Cultivation of buckwheat offers outstanding benefits as part of a regenerative crop rotation. Its fast growth suppresses weeds, while its deep, fibrous root system mobilizes phosphorus. Our experiment was set up in 2020 in Nyíregyháza, Hungary, in which we investigated the effect of buckwheat on soil organic matter and available P content, and as a preceding crop of corn in crop rotation in case of different nutrient supply levels (control; N80; N80P96K96). During the three-year study period, an increase in soil organic matter content was observed in both the 0–25 cm and 25–50 cm soil layers. At all three nutrient supply levels, the most pronounced increase occurred in the upper soil layer, with the highest increase recorded under the treatment receiving 80 kg ha^{-1} N fertilizer (+0.95 m/m% in the 0–25 cm layer and +0.58 m/m% in the 25–50 cm layer). Regarding plant-available phosphorus (P), an increase was also detected in the upper soil layer after three years, with the largest increase observed in the 80 kg ha^{-1} N treatment (+227.70 mg kg^{-1} d.m.), despite the absence of P fertilization. This finding highlights the ability of buckwheat to enhance P availability. Concerning its value as a preceding crop, corn yields showed no significant differences among nutrient supply levels in the first two years. However, in the third year, the NPK treatment significantly outperformed the yield of control treatment. Our results confirm the beneficial effects of buckwheat in crop rotation, particularly in improving soil organic matter and available P content, as well as its excellent value as a preceding crop.

Preliminary Results of a Carbon Farming Cropping System in Hungary, and Evaluation of the Benefits of Integrating Buckwheat into Crop Rotation

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Keywords: Carbon sequestration in soil, carbon storage, CO_2 emissions, *Fagopyrum*, regenerative agriculture

The main aim of carbon farming is to decrease CO_2 emissions and boost carbon storage in soil and biomass by using eco-friendly farming methods.
The choice of crops plays a crucial role in this process, directly influencing the amount of carbon that can be sequestered and stored in the soil.
Each crop produces above- and below-ground biomass with different potential for the sustainable accumulation of soil organic matter.
Both cash and cover crops contribute differently to soil fertility in crop rotations, depending on their nitrogen and carbon content.
Key indicators for assessing the potential of crops to achieve carbon farming objectives include the C/N ratio, plant-available nitrogen, harvest index, and carbon content in different plant parts.
This work will present the preliminary results of a carbon farming initiative conducted in Hungary, which involved the use of precision agriculture technologies and Decision Support Systems (DSS). The project led to measurable carbon sequestration in the agricultural soils of selected pilot farms.
Building on this analysis, we aim to compare buckwheat with other crops and identify the most effective cropping system within the context of carbon farming and regenerative agriculture.

SESSION 4

Poster presentations

Chairperson:

Csaba Juhász

Alexandra Andreea Litoiu, Adriana Paucean, Claudiu Teofil Lung, Alexandru Zmucila and Maria Simona Chis: An Overview of Buckwheat – A Superfood with Applicability in Human Health and Food Packaging

Marta Hornyák, Katarzyna Karpierz, Zbigniew Miszalski, Miron Gieniec, Ulf Göransson and Błażej Ślązak: Metabolomic Profiling and Stable Isotope Discrimination in Floral Organs of Common Buckwheat (*Fagopyrum esculentum* Moench)

Ladislav Kováč and Božena Šoltysová: The Influence of Different Cultivation Technologies on the Changes of Quantitative and Qualitative Parameters of Buckwheat

Mala Ganiger, Jose Figueroa Cerna, Jayanta Roy, Richard Horsley: Genome-wide Association Study of Agronomic Traits in Common Buckwheat

Getalew Ayizengaw Chana, Gabriela Alandia, Daniel Marusig and Elisa Marraccini: Cultivar Screening of Common Buckwheat (*Fagopyrum esculentum* Moench) in Northern Italy

Getalew Ayizengaw Chana, Gabriela Alandia, Elisa Marraccini, and Emanuele De Paoli: Towards the Characterization of Common Buckwheat Germplasm in European Gene Banks through High-throughput Genotyping

An Overview of Buckwheat – a Superfood with Applicability in Human Health and Food Packaging

Alexandra Andreea Litoiu[1], Adriana Paucean[1], Claudiu Teofil Lung[2], Alexandru Zmucila[1] and Maria Simona Chis[1*]

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Keywords: Bioactive compounds, *Fagopyrum*, health benefits; sustainability

Buckwheat, a dicotyledonous pseudocereal from the Polygonaceae family, has emerged as a crop of scientific and industrial interest due to its exceptional phytochemical profile, adaptability to different environments, and minimal agronomic input requirements. This paper aims to highlight the proximate composition (carbohydrates, protein, dietary fiber, lipids, starch, vitamins and minerals) of buckwheat principal species, *Fagopyrum esculentum* Moench (common buckwheat) and *Fagopyrum tataricum* (L.) Gaertn. (Tartary buckwheat). Other bioactive compounds, including flavonoids (e.g., rutin, quercetin), phenolic acids, anthocyanins were emphasized together with their influence on human health. These constituents confer a broad range of biological activities such as anti-inflammatory, antimicrobial, antidiabetic, antihypertensive, and hypoglycemic effects. Moreover, buckwheat is inherently gluten-free, making it a valuable alternative in formulations targeting gluten-sensitive populations. Finally, the review addresses the possibility of using starch buckwheat as a raw material in starch-based films. Further research is warranted to elucidate the potential of buckwheat starch as a viable material for the development of biodegradable food packaging films.

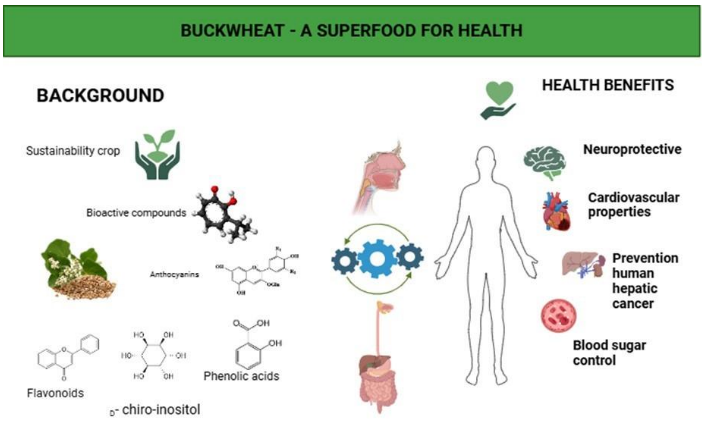

Figure 1. Graphical abstract – created in biorender.ro

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Metabolomic Profiling and Stable Isotope Discrimination in Floral Organs of Common Buckwheat (*Fagopyrum esculentum* Moench)

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Keywords: buckwheat, floral organs, GNPS, metabolomics, stable isotope

Common buckwheat (*Fagopyrum esculentum* Moench) is a valuable pseudocereal crop, with seeds recognized as a "superfood" of the 21st century due to their high nutritional and health-promoting properties [1]. However, its agricultural potential remains limited by poor seed yield, which makes it less competitive compared to major cereal crops [2]. The low productivity is largely attributed to floral biology—particularly the high rates of flower and seed abortion and the frequent developmental degeneration of the female gametophyte [3, 4, 5]. To date, metabolomic studies in particular parts of buckwheat flowers are scarce, despite their key role in reproductive success [6].

Our study aimed to characterize the metabolomic profile of distinct floral organs of common buckwheat, including pistils, stamens, floral receptacles, and corolla petals. Methanolic extracts from these tissues were analyzed using liquid chromatography–mass spectrometry (LC-MS), followed by molecular networking through the GNPS (Global Natural Products Social Molecular Networking) platform. Based on the molecular network, targeted profiling of selected metabolites—such as rutin, quercetin, isoquercetin, and fagopyrin—was carried out, with quantitative analysis performed using MassLynx and Skyline software.

In addition to metabolomic profiling, we carried out stable isotope discrimination analysis for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) within the same floral organs to provide insight into physiological processes linked to metabolic allocation and nutrient status [7].

Our findings offer a deeper understanding of the metabolomic complexity within buckwheat flowers and may help identify biochemical factors contributing to reproductive inefficiency. Ultimately, this research supports future strategies aimed at improving seed yield through a better understanding of metabolic function in reproductive tissues.

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The Influence of Different Cultivation Technologies on the Changes of Quantitative and Qualitative Parameters of Buckwheat

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Keywords: *Fagopyrum*, fertilization, gleyic Fluvisols, production, tillage technologies

Changes of the quantitative and qualitative parameters of the buckwheat were observed on gleyic Fluvisols (locality Milhostov, Slovak Republic) at different cultivation technologies between 2013 and 2015. The experiment was conducted using two soil tillage technologies: conventional tillage and reduced tillage, and three fertilization treatments: control, soil conditioner PRP SOL, and a combination of soil conditioner PRP SOL and plant auxiliary substance PRP SOL+EBV. At the same time, research into the basic physical properties of soil in buckwheat crops was also monitored. The significantly higher yields of buckwheat were achieved with conventional agrotechnology. In the variant with conventional tillage, better values of basic physical properties of the soil were recorded, i.e. lower values of soil bulk density and higher values of total soil porosity were found in comparison with the reduced tillage. The relationship between soil physical properties and buckwheat yield was also confirmed by a significant negative correlation between soil bulk density and yield ($r = -0.68$) and a significant positive correlation between total soil porosity and buckwheat yield ($r = 0.68$). Significantly higher yields of buckwheat were found with applications of adjuvants than with the control. The application of plant auxiliary substance PRP SOL+EBV on the variant with PRP SOL did not substantially increase yields of buckwheat. Significant differences were found in the buckwheat yield between years. The lowest yields of buckwheat were recorded in the dry and extremely hot year of 2015. The content of nitrogen substances in the grain of buckwheat was dependent on the fertilization options. Higher content of nitrogen substances in the grain of buckwheat was found in the control than with the application of adjuvants. A negative correlation was found between the yield and nitrogen substances in the grain buckwheat ($r = -0.66$).

Genome-Wide Association Study of Agronomic Traits in Common Buckwheat

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Keywords: BLUP, *Fagopyrum esculentum*, GWAS

Common buckwheat (*Fagopyrum esculentum*) is a pseudocereal in the family Polygonaceae. It is primarily cultivated for food due to its high nutritional and nutraceutical properties. Naturally gluten-free, buckwheat is rich in starch, minerals, vitamins, rutin, antioxidants, and dietary fiber, featuring a unique amino acid profile with elevated levels of lysine and arginine. In this study, we conducted a genome-wide association study (GWAS) to investigate the genetic basis of agronomic traits in buckwheat. Using 139 diverse genotypes, we evaluated 36 agronomic traits, including plant height, 1000-seed weight, yield, days to maturity, lodging, shattering, seed size, shape, and color. Phenotypic data were collected at Prosper and Carrington, North Dakota, in 2021 and 2022. The data were analyzed alongside 20,073 single nucleotide polymorphism (SNP) markers using the Genome Association and Prediction Integrated Tool (GAPIT) software with multiple loci mixed linear model (MLMM) and Fixed and Random Model Circulating Probability Unification (FarmCPU) approaches. Significant marker-trait associations ($P \leq 0.001$ or $-\log10p \geq 3.0$) for plant height, seed weight, and yield were identified: Chr 2, 6, 7, and 8 for plant height; Chr 4, 5, 6, and 8 for seed weight; and Chr 3 and 8 for yield. Identifying the causal loci for increased yield will aid marker-assisted selection to develop common buckwheat varieties with high yield potential and superior agronomic traits.

Cultivar Screening of Common Buckwheat (*Fagopyrum esculentum* Moench) in Northern Italy

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Keywords: Climate change, cultivar adaptation, low-input cropping systems, pseudo-cereal, resilience, sustainable agriculture

Common Buckwheat (*Fagopyrum esculentum* Moench) is a pseudo-cereal increasingly recognized for its valuable protein content, low input requirements, and its short growth cycle. Given its sensitivity to abiotic stresses, selecting the most stable and high-performing cultivars is essential to harness these benefits. The Friuli-Venezia Giulia (FVG) region, in northern Italy, has poorly diversified cropping systems, characterized by short crop rotations with few commonly grown species, mainly summer crops. This lack of diversity has led to pesticide resistances and poor resilience toward intense climatic events. Therefore, our objective is to identify buckwheat cultivars best suited for spring and summer sowing for their integration as main crops into FVG's cropping systems. In particular, we intended to identify cultivars demonstrating consistent performance, and resilience late spring frosts and summer heat waves which significantly affects flower abortion and grain filling of buckwheat. A first trial was conducted in 2024, with seven buckwheat cultivars tested at the experimental farm of the University of Udine. Cultivars Billy, Darja, Esquire, Kora, Hajnalka, Panda and Zirka were sown at the end of August and harvested in mid-November under a completely randomized block design with three replicates. Growth patterns, grain yield, and yield components were measured. Preliminary result showed, grain yields ranging from 0.520 to 1.1 tha-1, with Esquire having the lowest and Billy the highest values, respectively. Billy also showed the biggest grain size with a thousand seed weight (TSW) of 32g, whereas Hajnalka had the lowest TSW (24g). A spring trial has been sown in May 2025, while summer sowing is planned for the month of July. The experiment will be repeated in 2026. Ultimately, integrating the adapted cultivars identified through cultivar screening with other tools such as advanced selection and agronomic practices, will contribute towards sustainable food systems, and food security in the northern region of Italy.

Towards the Characterization of Common Buckwheat Germplasm in European Gene Banks through High-Throughput Genotyping

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Keywords: ddRAD-seq, genetic diversity, germplasm conservation, population structure, pseudocereal breeding

Common buckwheat (*Fagopyrum esculentum* Moench), a diploid pseudocereal belonging to the family Polygonaceae, is progressively recognized for its exceptional nutritional qualities, including high-quality gluten-free protein, abundant antioxidants, and various nutraceutical compounds. Its low input requirements and adaptability to challenging environmental conditions also make it a promising crop in the context of climate change. Thus, germplasm collection, characterization and maintenance are very important primary tasks for buckwheat breeding programs, that will be followed by the selection of the traits of interest and the breeding strategies. However, the publicly available buckwheat germplasm resources in Europe are poorly characterized at the genetic level. The aim of our project is to genotype a developing collection of common buckwheat accessions using high-throughput sequencing in order to understand the genetic diversity and population structure of these materials. This work constitutes a genotyping effort to genetically characterize nearly hundred accessions, with different geographic origins in Europe and Asia, mainly obtained from the Leibniz Institute of Plant Genetics and Crop Plant Research (IPK) in Germany, using the ddRAD-seq method. The generated genomic data are currently being utilized to assess the genetic diversity between accessions, perform phylogenetic analyses, and uncover the genetic structure of the collected germplasm. This will expand the information already available from other international collections and offer valuable insights for future breeding and conservation efforts.

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SESSION 5

Nutritional Values of Buckwheat, Food Production and other Processing Technology

Chairpersons:
Grazyna Podolska, Vivien Pál

Ivan Kreft, Blanka Vombergar, Maja Vogrinčič, Aleksandra Golob, Marjana Regvar, Katarina Vogel Mikuš, Paula Pongrac, Matevž Likar, Anja Mavrič Čermelj, Jacek Kwiatkowski and Mateja Germ: Nutritional Value of Buckwheat

Krzysztof Dziedzic, Patryk Mizera, Hossain Raihan Rakib, Anshu Rastogi and Jarosław Walkowiak: Dietary Fiber Content in Husk from Selected Common Buckwheat Cultivars Grown under Varying Irrigation Systems

Zlata Luthar and Katja Mlinarič: Condensed Tannins in Common and Tartary Buckwheat Seeds

_ and Shruti Joshi: Innovating Indian Chapaty with Germinated Buckwheat Flour for Glycemic Control

Nutritional Value of Buckwheat

Ivan Kreft [1*], Blanka Vombergar[2], Maja Vogrinčič[1], Aleksandra Golob[1], Marjana Regvar[1], Katarina Vogel Mikuš[1,3], Paula Pongrac[1,3], Matevž Likar[1], Anja Mavrič Čermelj[1], Jacek Kwiatkowski[4] and Mateja Germ[1]

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Keywords: Fiber, flavonoids, proteins, starch, vitamins

Buckwheat, both common (*Fagopyrum esculentum*) and Tartary (*F. tataricum*) are plants with exceptional nutritional value. Although starch is the main constituent of buckwheat grain, it is also a rich source of dietary fiber. Both soluble and insoluble fiber have their important value in the human diet. Fiber regulates digestion, binds unfavorable substances and helps to eliminate them from the body. In hydrothermal processes, especially in connection with husking while obtaining buckwheat groats (kasha), starch is transformed from easily digestible to slowly digestible one. Such retrograded starch acquires the function of dietary fiber and is a suitable substrate for beneficial microorganisms in the colon. The formation of retrograded starch could be accelerated by binding of rutin or other polyphenolic substances to starch. Common buckwheat and especially Tartary buckwheat are rich in a variety of phenolic substances that are important for maintaining human health. Buckwheat grain are a suitable dietary source as well of proteins, minerals, beneficial fatty acids and vitamins of the group B.

This paper is dedicated to Christian Zewen (1959 – 2022), a committed collaborator and promoter of the cultivation and utilization of common and Tartary buckwheat and organizer of the 1st European Symposium on Buckwheat in 2015 in Luxembourg (1st EuroIBRA).

Dietary Fiber Content in Husk from Selected Common Buckwheat Cultivars Grown under Varying Irrigation Systems

Krzysztof Dziedzic [1,2*], Patryk Mizera[1], Hossain Raihan Rakib[1], Anshu Rastogi[1] and Jarosław Walkowiak[2]

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Keywords: Drought stress, silicon treatment, soluble and insoluble dietary fiber

Common buckwheat is widely grown, but underutilized by food producers. Processing its grains produces by-products like husk and bran, making up about 30% of the raw material. These residues are rich in health-promoting compounds such as flavonoids, phenolic acids, and dietary fiber. Due to its resilience to environmental changes, buckwheat is a promising crop amid climate change. Therefore, this study aimed to assess the dietary fiber content in three buckwheat varieties grown under different irrigation conditions. Buckwheat cultivars: La Harpe, Smuga, and Panda, were treated under two irrigation conditions: regularly irrigated and non-irrigated. Within these conditions, one group were described as a treatment (T) received a foliar application of silicon, as 1 mM solution of sodium metasilicate nonahydrate ($Na_2SiO_3 \cdot 9H_2O$) @400 L ha^{-1} for twice, while the other was sprayed with water – described as a control (C).

Buckwheat husk extracts were shredded using a knife mill to a particle size of less than 132 μm. Detergent dietary fiber (NDF) and its fractions—cellulose (C), hemicellulose (H), and lignin (L)—were analyzed using the Van Soest method (Van Soest et al., 1991). Total dietary fiber (TDF), soluble dietary fiber (SDF), and insoluble dietary fiber (IDF) were determined using the AOAC enzymatic method (AOAC Method 991.43).

We observed varying concentrations of NDF, with the highest levels found in HIW (La Harpe cultivar under irrigated conditions with foliar water application), PNIW (Panda under non-irrigated conditions with foliar water application), SIS (Smuga under irrigated conditions with foliar silicon application), and PNIS (Panda under non-irrigated conditions with foliar silicon application), ranging from 82.3% to 82.6%. The lowest NDF concentration was recorded in PIW (Panda under irrigated conditions with foliar water application) at 80.5%. Hemicellulose (H) content was highest in PNIW (15.7%) and lowest in PIW (13.9%). In the Smuga cultivar, foliar silicon application led to an increase in cellulose (C) content by approximately 2.5%, while in the Panda cultivar, a similar trend was observed for lignin (L), which increased by about 6.8%. The highest contents of total dietary fiber (TDF) and insoluble dietary fiber (IDF) were found in PIW (90.6% and 88.8%, respectively) and HNIW (La Harpe under non-irrigated conditions with foliar water application) (90.25% and 88.9%, respectively). The soluble dietary fiber (SDF) fraction was highest in PIW (1.81%) and SNIW (Smuga under non-irrigated conditions with foliar water application) (1.75%).

This experiment demonstrates that cultivar selection can be a key factor influencing plant behavior under different irrigation conditions, as reflected in NDF and TDF content. Buckwheat may serve as an alternative crop in response to global climate change and increasing water scarcity.

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Condensed Tannins in Common and Tartary Buckwheat Seeds

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Keywords: Crops, *Fagopyrum*, genotype, species, tannins

Tannins are polyphenolic compounds, products of secondary metabolism, which are essentially responsible for the sensory properties and nutritional value of foods of plant origin. They are divided into four groups based on their chemical structure and properties: hydrolyzed, condensed, complex and pseudotannins. Buckwheat seeds contain the highest concentration of condensed tannins, and although they have significant health benefits, high levels of tannins can cause bitterness and astringency, which has a negative impact on consumption. Condensed tannins or proanthocyanidins are oligomeric or polymeric flavonoids with flavan-3-ol units (Amarowicz and Pegg, 2024). A high content of condensed tannins is nutritionally undesirable as they precipitate proteins, inhibit the action of digestive enzymes and can also impair the absorption of vitamins and minerals. They are also characterized by numerous positive properties, in particular antioxidant, anti-inflammatory and anti-nutritional properties that prevent the development of cardiovascular diseases, cancer, osteoporosis and diabetes and absorb low molecular weight compounds and metabolites from colonic fermentation that can have negative systemic effects on various organs (Cosme et al., 2025). The condensed tannins were analysed using the vanillin HCl method (Muchuweti et al., 2005) in the seeds of common and Tartary buckwheat genetic resources. The seeds of 9 crops (wheat, spelt, barley, oats, rye, maize, millet, sorghum and hemp) were also analysed as a comparative standard. The analysed data were statistically processed using analysis of variance, and the significant differences were calculated using Duncan's multiple range test. A statistically significant higher tannin content (1.78 $mg.g^{-1}$ DW) was found in common buckwheat than in Tartary buckwheat (1.17 mg.g-1 DW). Significant differences in tannin content were also found within the two buckwheat species. Of the nine selected crops, no tannins were detected in five (wheat, barley, oats, rye, millet), while sorghum differed from the others with a content of 2.1 $mg.g^{-1}$ DW. Both buckwheat species contain satisfactory amounts of tannins compared to the other crops. Due to their properties, large amounts of tannins are not desirable as they can have a negative effect on human metabolism.

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Innovating Indian Chapati with Germinated Buckwheat Flour for Glycemic Control

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Keywords: Germinated Buckwheat; Gluten-free Chapati; Glycemic Index; Starch Digestibility

With growing consumer awareness of gluten intolerance and metabolic disorders, the demand for culturally rooted, functional, gluten-free alternatives is increasing globally. This study aimed to develop a gluten-free Indian flatbread (*chapati*) using germinated buckwheat flour and to validate its nutritional quality, and glycemic behaviour through *in vitro* and *in vivo* analysis.

Germination significantly enhanced protein (15.48%), dietary fiber (13.15%), and bio actives such as rutin and GABA, while reducing antinutrients (phytic acid: 0.07%) in chapati. The resulting chapati was free from gluten (<5 ppm), with an acceptable texture (hardness: 2.81 N) and puffing height (3.8 mm), comparable to conventional chapati performance.

Functional characterization showed superior antioxidant capacity, improved mineral content (Fe: 5.64 mg/100g; Mg: 272.29 mg/100g), and lower rapidly digestible starch (10.48%) with higher resistant starch (23.94%). *In vitro* hydrolysis index was 16.66, with estimated GI of 48.86 and GL of 11.67. However, *in vivo* trials on human subjects confirmed a low glycemic index (GI: 37.42), classifying it as a low-GI food. Strong positive correlation ($R^2 > 0.90$) was observed between *in vitro* and *in vivo* GI values.

SEM imaging revealed uniform starch-protein matrices with reduced porosity, while FTIR spectra confirmed structural shifts related to germination-induced enzymatic remodeling. Rheological analysis demonstrated improved dough viscoelasticity via creep recovery studies as compared to native dough. During short-term storage (0–48h), the chapatis maintained moisture stability (32.25% to 32.01%), colour, and textural integrity.

This study offers a minimal-processed, culturally familiar gluten-free staple that addresses both celiac concerns and glycemic regulation. Given rising global prevalence of gluten-related disorders and type 2 diabetes (WHO, NIDDK, CDF), this innovation supports inclusive dietary transitions using indigenous buckwheat varieties with green label potential.

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Short Biographies of the Speakers

Prof. Taiji Adachi

Principal / Director; NPO,
Colloquia Naturae in Miyazaki, Japan

Prof. Taiji Adachi graduated from Kyoto Univ., Faculty of Agriculture in 1964. After his graduation he was employed to be an Assistant (Teaching Stuff) of Kyoto Univ. In 1967 he moved to Miyazaki Univ. as a Teaching Instructor and a Chief Manager of Botanical Garden. He got Ph. D (Plant Genetics and Breeding) at Kyoto University and promoted to be Associate Professor of Miyazaki Univ. in 1972. At the age of 31 he was invited as a Fellow of Alexander von Humboldt Foundation, BRD (W. Germany at that time) for one and a half years. He has been active on novel Plant Biotechnology, especially concern to overcome breeding barriers in different reproductive systems, *heterostylism* and *apomixis*. For decades in 20C, he performed presentations not only in different Int'l Academic Congresses and Symposia, but also sometimes committee member of Int'l Meetings. He was Vice President of the Japanese Society of Breeding for 4 years after moving to Osaka Prefecture University to 2005. After retirement from OPU, Prof. emer. he was employed to Osaka University and Korean National Jeju Univ. for almost decade. Now he organizes a non-profit organization "***Colloquia Nature* in Miyazaki**" as the principal/director.

Prof. Meiliang Zhou

Research Group of Buckwheat Genetic Germplasms in the Institute of Crop Sciences, Chinese Academy of Agricultural Sciences, Beijing, China

Prof. Meiliang Zhou is the head of the Research Group of Buckwheat Genetic Germplasms in the Institute of Crop Sciences, Chinese Academy of Agricultural Sciences, Beijing, China. He has engaged in research on buckwheat germplasm resources and genetic breeding. His research team focus on genetic variations exploration through whole genome association study and comparative genome analysis and genetic mechanisms analysis of key agronomic, quality and adaptability traits in buckwheat. Using excellent germplasm resources and molecular markers developed based on excellent variation, they bred 9 buckwheat varieties. As the corresponding author, he has published 45 papers in Advanced Science, Genome Biology, Molecular Plant, Plant Cell, etc. He is serving as an editorial board member for SCI journals such as The Innovation, BMC Biology, and Journal of Genetics and Genomics, and also serving as the Executive Chairman of the 16th International Buckwheat Association.

Anika Wiese-Klinkenberg

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I am a biologist with a major interest in the bioeconomic utilization of plants for food and for an extraction of valuable plant special metabolites. My research focuses on the plant's reaction to abiotic, environmental stress and the fascinating ability of plants to withstand such stresses by molecular tolerance responses and also by stress memory. Aiming for a sustainable food production we evaluate the utilizisation of horti-/or agricultural side-streams for the extraction of special metabolites. I studied biology in Cologne, Germany, where I also achieved my doctorate degree, this was followed, by a postdoc in Utrecht the Netherlands. Then I was applied as a group leader and scientist at Forschungszentrum Juelich in Germany. In my group we use phenotyping technologies to quantify plants stress responses, and we use methods for the quantification of plants special metabolites and their accumulation due to abiotic stresses. Gene expression studies support the elucidation of the mechanisms of stress reactions and the identification of special metabolites biosynthesis genes.

Recently we started the project BIMOTEC researching resilient buckwheat production and a possible multi use for food, lignocellulose and extraction of valuable plant secondary metabolites.

Mateja Germ

University of Ljubljana, Ljubljana, Slovenia

Mateja Germ had her PhD in 2000 in Biology at the University of Ljubljana, Biotechnical Faculty (UL BF), Ljubljana, Dep. of Biology; since 2020, she has been a Full Professor of Ecology at UL BF. M. Germ led many Slovenian and two international SRIA projects (Impact of selenium on the yield and quality of crop plants, and Physiological indicators of stress in cultivated plants). She has cooperated with international research institutions such as Sichuan Agricultural University, China, the University of Wrocław, Poland and Slovak Agricultural University in Nitra, Slovakia. M. Germ was the mentor of several PhD students and many master's students, and the supervisor of young researchers. The main topic of her research is focused on the response of crops to different kinds of stress, the quality of crops, and the optimisation of buckwheat for sustainable use. M. Germ has a long time of experience in the research of the effects of environmental factors on buckwheat. She is the national expert and coordinator on aquatic plants' implementation of the European Union Water Framework Directive.

Md. Rakib Hossain Raihan

Ph.D. Candidate, Laboratory of Bioclimatology,
Department of Ecology and Environmental Protection
Faculty of Environmental and Mechanical Engineering
Poznań University of Life Sciences Wojska Polskiego 28,
60-637 Poznań, Poland

Md. Rakib Hossain Raihan is currently a Ph.D. candidate at the Department of Ecology and Environmental Protection, Poznań University of Life Sciences, Poland. He completed his Bachelor of Science in Agriculture (Hons.) and Master of Science in Agronomy from Sher-e-Bangla Agricultural University, Bangladesh. He joined the Ph.D. program in 2023, and his doctoral research focuses on the impact of silicon on the spectral and physiological traits of buckwheat under water-limited conditions. His research expertise lies in plant stress physiology, with a particular focus on mitigating abiotic stresses through the application of organic and inorganic elicitors.

Raihan has contributed to multiple national and international research projects and has published 13 Scopus-indexed articles. He received the Dean's Merit Award for academic excellence during his undergraduate studies and was awarded the National Science and Technology Fellowship in recognition of his Master's research. He has actively participated in numerous scientific conferences and has been recognized with Best Oral Presentation awards. He is also engaged in academic training, interdisciplinary collaborations, and scientific outreach.

Milan Skalický

Researcher, Dep. of Botany and Plant Physiology, Faculty of Agrobiology, Food and Natural Resource

Milan Skalický has worked at the Department of Botany and Plant Physiology for over 20 years. He focuses on the structural characteristics of plants and their responses to various stimuli (abiotic and biotic), phytochemical reactions of crops, and the management of anthropogenically disturbed areas (former military sites, spoil heaps). He has published over 160 scientific articles, which have been cited 5,500 times, with an H-index of 47.

Dr. M. A. Mannan Professor

Department of AgronomyFaculty of Agriculture, Gazipur Agricultural University, Gazipur-1706, Bangladesh & Former General Secretary, Ecological Society of Bangladesh

Professor Dr. M. A. Mannan is a prominent agricultural scientist and Professor of Agronomy at Gazipur Agricultural University (formerly BSMRAU), Bangladesh. With over 27 years of academic and research experience, he has made significant contributions to the field of crop physiology, abiotic stress management, and sustainable agronomic practices. Dr. Mannan earned his B.Sc. Ag. and M.S. (Agronomy) degrees from Bangladesh Agricultural University and completed his Ph.D. in Crop Agronomy with specialization in salinity stress physiology and Post doc. from Shenyang Agricultural University, China.

Professor Mannan's research primarily focuses on enhancing the resilience of field crops - particularly soybean, mustard, maize, and legumes - under challenging environments such as salinity, drought, and waterlogging. His work integrates physiological, biochemical, and molecular insights to develop stress-mitigating strategies including seed priming, foliar nutrition, and soil amendments like biochar and organic composts. His recent interests extend into the interface of sustainable agriculture and climate-smart practices, including biofuel feedstock development on marginal lands.

He has authored and co-authored over **74 research articles**, including publications in high-impact international journals such as *Waste Management*, *Paddy and Water Environment*, *Journal of Crop Science and Biotechnology*, the *Australian Journal of Crop Science, PeerJ journal, Frontiers in Plant Science, Scientific Reports and Heliyon*. He has also contributed to book chapters and monographs on stress physiology and sustainable agriculture.

As Principal Investigator and Research Lead, Dr. Mannan has successfully implemented numerous projects funded by the University Grants Commission, Ministry of Science and Technology, USDA, Krishi Gobeshona Foundation, BAS-USDA and other national bodies. His leadership has helped develop location-specific agronomic packages and adaptation strategies for vulnerable agroecological zones of Bangladesh, contributing to policy dialogues on food security and resource-efficient farming.

Beyond research, Dr. Mannan is deeply committed to academic development. He has supervised more than 50 post graduate theses on salinity tolerance, drought mitigation, carbon management, and physiological performance of stress-tolerant crops. His mentorship and scientific rigor have produced a new generation of young researchers in crop science.

Professor Mannan is frequently invited to speak at national and international conferences, and he collaborates with interdisciplinary teams working on sustainable land use, biofertilizers, and renewable agricultural systems. His scientific insight, dedication to innovation, and commitment to farmer-centric solutions position him as a key voice in shaping resilient agronomic strategies for the Global South.

Csaba Juhász

Kerpely Kálmán Doctoral School of Crop Production and Horticultural Sciences, University of Debrecen, Debrecen, Hungary

I earned my BSc degree in Agricultural Engineering and my MSc degree in Plant Protection Engineering. During my university years, I participated in an international summer internship at the University of Technology and Life Sciences in Bydgoszcz, Poland I was awarded both the National Higher Education Scholarship and the New National Excellence Programme Scholarship. I actively engaged in academic research, presenting at both institutional and national Scientific Student Conferences. Since September 2021, I have been a PhD student at the Kerpely Kálmán Doctoral School, where my research focuses on developing plant protection technologies for alternative crops, with a particular emphasis on herbicide-based weed control strategies for under-researched species. Several of our research papers have been published internationally and we have participated in international conferences.

Vivien Pál

University of Debrecen, Institutes for Agricultural Research and Educational Farm, Research Institute of Nyíregyháza, Nyíregyháza, Hungary

I have been working at the Research Institute of Nyíregyháza since 2019, my primary research centers on integrating legumes and alternative plants into crop production to enhance biodiversity, protect soil health, and reduce greenhouse gas emissions. Our experiments aim to evaluate the role of cover cropping and green manuring as regenerative practices in crop rotation, and investigate how various agrotechnical practices affect the seed production of these alternative species (lupine, vetches, oil radish, buckwheat, etc.).

Prof. Ivan Kreft

University of Ljubljana, Ljubljana, Slovenia

Ivan Kreft graduated at Ljubljana University in Biology and Agronomy, at the University of Lund, Sweden obtained M.Sc. in Genetics, in Ljubljana Ph. D., and at Slovak Agricultural University in Nitra, Slovakia, received his Dr. h.c. From 1983 Professor teaching genetics, and evaluation of plant products, for the students of agronomy, biology, biotechnology, food science and nutritional studies at University of Ljubljana, Slovenia. In 1992-1993 visiting professor at Kyoto University, Japan, in 2001 visiting professor at Shanxi University, Taiyuan, China, in 2010 visiting professor at Kobe Gakuin University, Japan. He performed many field experiments and scientific excursions in Europe, China, Korea, Japan, Bhutan, Philippines, and Australia (Tasmania). Former First Chairman of IBRA (1980-1983) and again IBRA Chairman in 2013-2016. Member of Slovenian Academy of Sciences and Arts. Editor of Fagopyrum journal, author or co-author of several books on buckwheat, published in Slovenian, English, German and Japanese language.

Dr. Krzysztof Dziedzic

Poznań University of Life Sciences, Poland

Dr. Krzysztof Dziedzic is employed as a lecturer at the Poznań University of Life Sciences, Department of Food Technology of Plant Origin, and as a part-time researcher at the Poznań University of Medical Sciences, Department of Paediatric Gastroenterology and Metabolic Diseases, Poland. His research focuses on the design of bio-foods with health-promoting properties. He studies the bioavailability of food components through in vitro experiments that simulate the human gastrointestinal tract.

His primary scientific interest lies in the use of buckwheat grain to improve the nutritional quality of food products. He also investigates the effects of environmental changes on the nutritional value of buckwheat as a raw material. Additionally, he explores bioactive substances isolated from cereals and pseudocereals.

By combining expertise in environmental engineering, food science, and healthcare, Dr. Dziedzic analyzes the impact of climate change on the nutritional quality of food, aiming to contribute to the prevention of lifestyle-related diseases.

Akanksha Dalal

PhD Scholar, Grain Science and Technology Department
CSIR-CFTRI, Mysuru, India

I, Akanksha Dalal, am a final-year PhD scholar in the Grain Science and Technology Department at CSIR-Central Food Technological Research Institute (CFTRI), Mysuru, India. My research focuses on the characterization and modification of buckwheat and its starch for developing gluten-free, low glycemic index food products and in vivo validation. I recently published two papers on gluten-free noodles and protein-rich Indian snacks using processed buckwheat flour and received a Best Poster Award for my work on buckwheat starch residue valorization. I am passionate about creating culturally relevant, clean-label food solutions for managing metabolic health and gluten sensitivity.

Matteo Ruggeri

Sustainability & Carbon Farming Project Manager Field trials sites Manager

I am an agronomist in Horta srl with a PhD in assessing the sustainability of farming practices. I specialise in web-based Decision Support Systems (DSSs) for cereal crops. Horta srl is an Italian tech-company that provides digital solutions for the agricultural sector and the agri-food supply chain. Its mechanistic and AI-based forecasting models support sustainable agricultural production. Horta's digital products and services provide location-specific information and recommendations to help farmers make data-driven decisions. Aggregating this data contributes to the digitalisation of the agri-food sector and enables agri-food companies to quantify the sustainability of their raw materials. Nowaday my role involves managing sustainability and carbon farming projects, as well as coordinating Italian field trial sites.

Dr. Marta Hornyák

W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Cracow, Poland

Dr Marta Hornyák is an Assistant Professor at the W. Szafer Institute of Botany, Polish Academy of Sciences, in Kraków, Poland. She specializes in the reproductive biology of common buckwheat (Fagopyrum esculentum), focusing on embryo sac degeneration and its impact on seed yield. Her research explores the role of secondary metabolites in buckwheat flowers, particularly phototoxic fagopyrins, using advanced techniques such as high-performance liquid chromatography–mass spectrometry (LC–MS), matrix-assisted laser desorption/ionization mass spectrometry imaging (MALDI–MSI), stable isotope discrimination, and untargeted metabolomics with platforms including GNPS and MZmine.

Dr hab. Jacek Kwiatkowski

Department of Genetics, Plant Breeding and Bioresource Engineering, Faculty of Agriculture and Forestry, University of Warmia and Mazury in Olsztyn, Poland

Dr hab. Jacek Kwiatkowski has been working at the Department of Genetics, Plant Breeding, and Bioresource Engineering (formerly the Department of Plant Breeding and Seed Production) at the University of Warmia and Mazury in Olsztyn, Poland since 1991. He is currently employed as a professor at the UWM. He has completed several international internships, including two post-doc fellowships at NYSAES Cornell University in the USA. A predominant part of his research focuses on seed science, technology and production in its broadest sense. These include improving seed production technologies for selected agricultural and alternative plant species, including buckwheat, cultivar and seed degeneration, seed biology, and assessing the quality of seed and propagation material for agricultural and energy crops or forest species.

Mala Ganiger

Minn-Dak Ag LLC, Grand Forks, ND, USA

Mala Ganiger is the Director of Research and Development at Minn-Dak Ag LLC. Grand Forks, ND, USA, which is a food-based company specializing in buckwheat and mustard milling. Mala is responsible for buckwheat breeding projects focusing on improvement of nutritional and food safety aspects of buckwheat. She is also a PhD Candidate in the Department of Plant Sciences, North Dakota State University, Fargo, ND. Her doctoral research focuses on identifying the genomic regions responsible for the seed coat color in common buckwheat using Genome-wide association study (GWAS), high-throughput phenotyping, and assessing the impact of accelerated aging on loss of seed coat color.

Alexandra Hanász

University of Debrecen, Institutes for Agricultural Research and Educational Farm, Research Institute of Nyíregyháza, Nyíregyháza, Hungary

She is a research assistant at the Research Institute of Nyíregyháza, IAREF University of Debrecen. She has been working at the Research Institute of Nyíregyháza since 2015. Currently, she is a PhD candidate at the Kerpely Kálmán Doctoral School of Crop Production and Horticultural Sciences. Her doctoral dissertation focuses on the osmotic stress tolerance and drought resistance of potato genotypes. At the research institute, she has conducted experiments related to the osmotic stress tolerance of potatoes, cereals, and other field crops.