

Advancing Botanical Research: From Functional Genomics to Sustainable Crop Production

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The intrinsic complexity of plant biology underpins global food security, ecological stability, and the green bioeconomy. At the nexus of modern botanical science lies the challenge of understanding how plants adapt to dynamic environments, manage nutritional homeostasis, and synthesize specialized metabolites. As climate change accelerates environmental stressors such as soil salinization and shifting micronutrient availabilities, understanding these botanical processes from a molecular, physiological, and systems-level perspective becomes paramount. Addressing these multifaceted challenges requires integrating classic agronomic evaluations with next-generation multi-omics, functional genomics, and advanced biorefinery innovations.

In response to these critical needs, we introduce the inaugural issue of the *Journal of Phytological Sciences*, a peer-reviewed, open-access forum dedicated to advancing research across the entire spectrum of plant biology, including phytochemistry, plant physiology, molecular genetics, and agrotechnology, etc. Embracing integrative, multidisciplinary paradigms, the journal provides a high-impact platform for original research, critical reviews, meta-analyses, and short communications.

Our inaugural issue features four seminal contributions that collectively span the continuum from field-level crop stress evaluations to advanced computational systems biology and industrial bioproduct valorisation:

Kumar *et al.* provide a comprehensive review of micronutrient dynamics in purple cauliflower (*Brassica oleracea* var. *botrytis*), a high-value functional vegetable known for its antioxidant-rich anthocyanin accumulation.^[1] It synthesizes how essential trace elements govern core physiological pathways, cellular homeostasis, and structural development.^[2] Crucially, the review delineates the precise molecular transport networks (including ZIP, BOR, and NRAMP systems) and transcriptional cascades that regulate structural genes (such as *PAL*, *CHS*, and *ANS*) within the anthocyanin biosynthetic pathway. They conclude by evaluating how CRISPR/Cas gene editing, AI-assisted precision nutrition, and nano-fertilizers can be deployed to build climate-resilient, nutrient-dense crops. Moving from herbaceous crop to woody plant matrices, Roghan *et al.* deliver a rigorous chemical synthesis of lignin and its associated polyphenolic compounds.^[3] As the Earth's second most abundant natural biopolymer, lignin features exceptional structural flexibility, UV-shielding capacities, and radical-scavenging properties. The authors map out monolignol biosynthetic pathways across various plant taxa and critically evaluate advanced structural characterization methodologies, including 2D 1H-13C HSQC NMR, 31P NMR, Py-GC/MS, SEC/GPC, and FTICR-MS. By linking extraction protocols with quantitative performance metrics (such as DPPH IC50 and SPF values), this framework bridges taxonomic plant chemistry with commercial

bioproduct engineering to support a sustainable bioeconomy.^[4] Addressing the overarching regulatory mechanisms of specialized plant chemistry, Gole *et al.* evaluate the systems biology of secondary metabolism.^[5] Plant secondary metabolites are vital for environmental adaptation and defense, while also serving as major resources for the pharmaceutical and agricultural industries.^[6,7] The authors highlight how integrating multi-omics, such as genomics, transcriptomics, proteomics, and metabolomics with AI-driven network biology resolves complex regulatory networks. The review outlines the future potential of single-cell omics, pan-genomics, and next-generation predictive modeling to accelerate precision breeding and the sustainable engineering of high-value phytochemicals. Shifting to regional, field-level climate challenges, Miah *et al.* examine the direct impacts of coastal soil salinity on cabbage (*Brassica oleracea* var. *capitata*) yield and mineral architecture across the Patuakhali and Barguna districts of Bangladesh.^[8] Through rigorous tissue analysis of crops grown along variable electrical conductivity (EC) gradients, the authors map out complex nutrient-uptake responses. While extreme salinity thresholds (EC = 9.31 dS m⁻¹) severely depressed overall crop yields and mineral accumulation, moderate thresholds revealed non-linear accumulation peaks for essential macro- and micro-minerals.^[9,10] This field surveillance offers vital baseline data for localized agricultural strategies aimed at safeguarding regional nutritional security.

Collectively, these inaugural contributions demonstrate that safeguarding agricultural productivity and maximizing plant utility relies on a continuous feedback loop between field observations and fundamental molecular research. They also delineate recurrent translational challenges such as multi-omics data integration, agricultural scalability, and structural heterogeneity in biomaterials, which we encourage future contributors to address in forthcoming issues.

The Editorial Office remains dedicated to a rigorous, transparent, and timely peer-review process adhering to the highest standards of scientific and ethical integrity. We warmly invite plant biologists, agronomists, biochemists, and computational biologists to contribute their work and assist in establishing the *Journal of Phytological Sciences* as a premier venue for integrative plant research.

Conflict of Interest

There is no conflict of interest.

Artificial Intelligence (AI) Use Disclosure

The author declare that artificial intelligence (AI)-assisted tools were used only for language refinement, grammar improvement, and manuscript structuring purposes during the preparation of this work. All content and interpretations were reviewed and verified by the author.

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