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News and Views

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Insights into camelina accessions: evaluating trait plasticity under heat and drought stress

Munkhtsetseg Tsednee [1,2]*

[1]Assistant Features Editor, Plant Physiology, American Society of Plant Biologists
[2]Research Center for Environmental Changes, Academia Sinica, Taipei 11529, Taiwan

*Corresponding author: Email: mugi@as.edu.tw

Plants differ widely in their tolerance to environmental stresses. Diversifying cropping systems with better-adapted species can, therefore, help stabilize agricultural productivity under increasingly variable climatic conditions (Lin 2011). Camelina (*Camelina sativa*), a traditional oilseed crop, exhibits tolerance to drought and heat stress (Zanetti et al. 2021; Smith et al. 2024). Its seed oil is used for biofuel and feedstock, in addition to food and nutritional applications, making camelina a promising crop for enhancing agronomic resilience and performance (Zanetti et al. 2021). Understanding stress tolerance in Camelina could be particularly informative, although it may play a limited role in the broader context of improving food security.

In a recent issue of *Plant Physiology*, Silvestre et al. (2026) investigated the trait plasticity in camelina accessions exposed to heat and drought stress and proposed an integrated assessment framework for evaluating their stress resistance.

The authors used 54 spring-type camelina accessions (Luo et al. 2019), representing the genetic diversity of 8 subpopulations defined by sequencing data, and focused on early-stage (juvenile) responses to heat and drought stress. Despite substantial phenotypic variation among accessions, heat stress generally promoted camelina growth, whereas drought suppressed it.

At the leaf metabolite level, heat and drought triggered distinct responses in camelina. Drought induced the accumulation of major biomass-related metabolites, such as soluble sugars and amino acids, in contrast to heat stress, which reduced their levels except for starch. Untargeted metabolomics further identified stress-related metabolic markers, including phenylpropanoids, benzenoids, carbohydrates, and lignans, that were differentially associated with heat and drought treatments. As expected, metabolic responses also varied strongly among camelina accessions, indicating that metabolic adjustment is a critical component of responses to both stresses. In addition, lipid remodeling emerged as an accession-specific indicator of stress, as revealed by leaf fatty acid analyses in both juvenile and mature plants grown under controlled laboratory conditions and in multi-location field trials, respectively (Silvestre et al. 2026).

Silvestre et al. (2026) further conducted detailed physiological assessments of camelina leaves by measuring water content, Δ^{13}C and Δ^{15}N isotope discrimination, total antioxidant capacity, and relative chlorophyll content. Since these traits are well-known indicators of abiotic stress, the authors observed strong, yet accession-dependent differences in their responses. Overall, heat increased leaf Δ^{15}N and antioxidant capacity, while drought reduced water content, accompanied by elevated Δ^{13}C.

By integrating developmental, physiological, and biochemical traits, principal component analysis (PCA) subsequently revealed a clear separation between heat and drought stresses, with developmental traits and fatty acid profiles contributing strongly to this distinction. The PCA also classified camelina accessions as responsive or unresponsive lines to heat or drought (Silvestre et al. 2026). These results indicated that early-stage leaf phenotyping in camelina can effectively identify stress tolerance within germplasm resources.

However, controlled laboratory approaches to enhance stress resilience often face challenges when translated to field conditions (Zhang et al. 2004). To link accession-specific stress responses with agronomic performance and the behavior of mature plants under field conditions, the authors lastly evaluated the phenotypic traits, such as yield, stand height, thousand grain weight (TGW), and seed oil content and composition in camelina lines grown at 3 contrasting environments (Italy, drought; France, heat; and UK, temperate). Although seed oil traits and TGW remained relatively stable across sites, other phenotypes varied substantially. Notably, field performance did not consistently align with stress responsiveness obtained under controlled conditions, indicating that agronomic outcomes are not associated with low phenotypic plasticity. Instead, high metabolic plasticity was associated with improved field performance, highlighting it as an indicator of stress resilience (Silvestre et al. 2026).

Furthermore, metabolomic profiles under drought, but not heat stress, showed a moderate correlation with genomic structure, indicating that genetic background only partially explains camelina's metabolic responses to drought. This also suggests that camelina may be inherently adapted to drought, with specific tolerance-related pathways or metabolites under genetic control and shared among related genotypes. The weak correspondence between genomic clustering and agronomic performance further indicated that camelina

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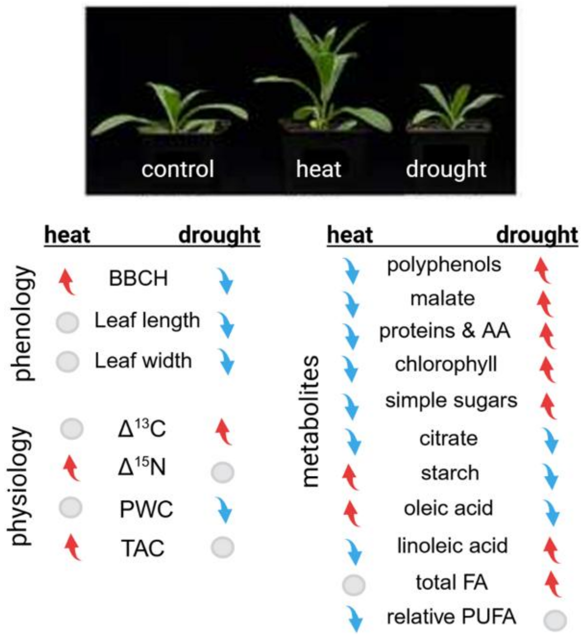

Figure 1 Summary of the multilevel stress responses of camelina to heat and drought stress. Selected variables are shown to indicate overall morphophysiological (phenology, physiology, and metabolic) responses shown by juvenile leaves to treatment. Red and blue arrows denote increase and decrease, respectively. Gray dot denotes nonsignificant change. BBCH, scale of phenological growth stages; PWC, plant water content; TAC, total antioxidant capacity; FA, fatty acids; PUFA, polyunsaturated fatty acids (modified from Silvestre et al. (2026)).

agronomic traits are shaped by more complex, multifactorial influences rather than genetic structure alone (Silvestre et al. 2026).

In summary, by applying a combinatorial phenotyping approach incorporating metabolic, biochemical, physiological, and developmental traits, Silvestre et al. (2026) established an integrated framework for assessing early-stage stress response in camelina (Fig. 1) and linked these responses to field performance. This strategy provides a practical foundation for breeding climate-resilient camelina varieties and for promoting crop diversification in agricultural systems.

Recent related articles in *Plant Physiology*

- Haslam et al. (2025) highlighted *C. sativa* as a resilient, fast-growing oilseed, well-suited for metabolic engineering of seed lipids and for translating lab research to field applications.
- Napier (2025) discussed the steps and strategies for overcoming challenges in converting scientific discoveries into marketable products, with examples drawn from camelina research.

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Conflicts of interest

None declared.

Data availability

No new data were generated or analyzed for this article.

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